



Graphene Oxidative Silicon Technology (GHOST™) Found in Human Tissues and Removed by Mineralised Nano-Sized Clinoptilolite

Robert O Young* and Caroline Mansfield

Department of Research, Innerlight Biological Research and Education Foundation, USA

***Corresponding Author:** Robert O Young, Department of Research, Innerlight Biological Research and Education Foundation, USA

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Abstract

This exploratory pre-post cohort study investigated the presence, anatomical distribution and longitudinal change of second-harmonic-dominant nonlinear junction detector (NLJD) responses in 22 human participants during a defined 63-day supplementation period with MasterPeace® Zeolite-Z®. Nonlinear junction detectors are established instruments used to identify nonlinear electronic junctions through analysis of harmonic return signals, with second-harmonic-dominant responses characteristically associated with semiconductor-type junction behaviour. The EDD-24XT used in this study classifies this response pattern as “Probability Silicon,” providing the operational basis for recording signals consistent with synthetic silicon-based electronic circuitry. Although semiconductor nanowires, graphene-associated conductive interfaces, flexible mesh electronics and other miniaturised bioelectronic systems have been developed to interface with biological cells and tissues, the consistent detection and anatomical distribution of second-harmonic-dominant NLJD responses in human subjects has not previously been systematically evaluated within a defined cohort.

Twenty-two participants (12 female, 10 male; 26-75 years) were assessed at baseline and following 63 days of daily supplementation. Standardised full-body scanning was performed using an EDD-24XT nonlinear junction detector under controlled procedural conditions. Discrete anatomical locations demonstrating qualifying second-harmonic-dominant responses were recorded as Active Signal Spots. Signal Intensity was recorded at each site and aggregated to calculate a participant-level Signal Intensity Score, while Mean Signal Intensity per Detection Site was used to distinguish changes in the number of detectable sites from changes in the intensity of responses remaining detectable.

Second-harmonic-dominant responses classified by the EDD-24XT as “Probability Silicon” were detected in all 22 participants at baseline and demonstrated a recurrent anatomical distribution across the cohort. Following 63 days of supplementation, mean Signal Intensity Score decreased from approximately 1,340 to 277 (–79%), mean Active Signal Spots decreased from approximately 21 to 7 per participant (–67%), and Mean Signal Intensity per Detection Site decreased from approximately 64 to 40 (–38%). The reductions therefore reflected both fewer anatomically detectable signal locations and attenuation of the responses remaining detectable.

The findings are considered within the wider literature concerning semiconductor nanowires, graphene-associated bioelectronic interfaces, mesh nanoelectronics and Wireless Body Area Network technologies, and within co-author Young’s proposed Graphene Oxidative Silicon Technology (GHOST™) framework. Within this proposed framework, graphene-, oxygen- and silicon-associated materials are considered in relation to bioelectronic architecture and anatomically localised semiconductor-type nonlinear responses. The substantial temporal reductions observed during MasterPeace® Zeolite-Z® supplementation are additionally considered in

relation to the adsorption, ion-exchange and molecular-sieving properties of natural clinoptilolite and previous human analytical findings obtained within this research programme.

This study identified recurrent anatomically localised second-harmonic-dominant NLJD responses in all participants at baseline and substantial reductions across three complementary signal measures following the 63-day intervention. NLJD measurements identify nonlinear harmonic behaviour and do not independently establish the chemical or structural composition of the material responsible for individual detections. The findings therefore provide a basis for further investigation of the proposed GHOST™ framework and the potential role of clinoptilolite-based intervention. Independent replication incorporating controlled study designs and direct chemical and structural characterisation at corresponding anatomical locations is warranted.

Keywords: Nonlinear Junction Detector (NLJD); Second-Harmonic Response; Semiconductor; Silicon; Silicon Nanowires; Graphene; Graphene Oxide; GrapHene Oxidative Silicon Technology (GHOST™); Bioelectronics; Wireless Body Area Network (WBAN); radiofrequency (RF); Harmonic Detection; Active Signal Spots; Clinoptilolite; Zeolite; MasterPeace® Zeolite-Z®; Adsorption; Ion Exchange

Introduction

Nonlinear junction detection and the study rationale

Nonlinear junction detectors (NLJDs) are specialised radiofrequency instruments developed to detect nonlinear electrical junctions through analysis of harmonic return signals generated when a target is exposed to a controlled radiofrequency excitation signal [1,2]. In conventional electronic detection and technical surveillance countermeasures (TSCM), semiconductor junctions typically produce a predominantly second-harmonic response, whereas dissimilar-metal junctions and corrosion-related nonlinearities are more commonly associated with stronger third-harmonic responses [1,2]. This second-versus-third harmonic principle forms the basis by which NLJD instrumentation assists an operator in distinguishing responses associated with semiconductor-containing electronic components from other nonlinear targets [1,2].

The EDD-24XT instrument used in the present study operates at a transmission frequency of 2.4 GHz and monitors second- and third-harmonic responses at 4.8 GHz and 7.2 GHz, respectively [3]. These operating specifications enable the instrument to detect and differentiate nonlinear responses associated with semiconductor-containing electronics.

Although NLJD technology is established within electronic detection and TSCM applications, its systematic application to the human body has received little attention within structured cohort-based research. Investigative practitioners using RF and NLJD instrumentation have reported second-harmonic-dominant responses

at discrete anatomical locations in human subjects; however, these observations have predominantly arisen from operational, case-based or non-controlled investigative settings rather than peer-reviewed cohort studies.

Consequently, the prevalence, anatomical distribution, magnitude and temporal behaviour of such responses within a general-population cohort have not been established.

For the purposes of the present investigation, second-harmonic-dominant responses classified by the EDD-24XT as “Probability Silicon” are described as signals consistent with synthetic silicon-based electronic circuitry. This terminology describes the harmonic behaviour detected by the instrument and does not, by NLJD measurement alone, constitute direct elemental or chemical identification of the material responsible for the response. The present study therefore investigates the reproducibility, anatomical distribution and temporal behaviour of the detected phenomenon.

The observation of reproducible second-harmonic-dominant responses at anatomically localised sites raises a broader scientific question concerning whether such detections represent random environmental or material artefacts or a measurable phenomenon associated with the human subject. The development of modern semiconductor nanotechnology and bioelectronic medicine provides an important technological context in which this question can be examined.

Historical foundations of bioelectric and bioelectromagnetic research

The concept that endogenous electrical activity plays a fundamental role in biological organisation predates the development of modern semiconductor bioelectronics. Robert O. Becker's experimental research investigated naturally occurring electrical potentials, direct-current bioelectric phenomena and their relationship to biological regulation, tissue repair and regeneration. In early work, Becker mapped direct-current surface potentials and investigated bioelectric field patterns, subsequently reporting evidence interpreted as longitudinal direct current electrical activity associated with peripheral nerves [4,5].

Becker and colleagues further investigated whether very small electrical currents could influence cellular and regenerative processes. Experimental studies examined electrically associated cellular dedifferentiation [6], electrical changes accompanying fracture healing and tissue repair [7], and electrically stimulated partial regenerative responses in mammalian tissue [8]. Collectively, this work contributed to an early electrophysiological framework in which living tissues were considered not only in biochemical terms, but also as electrically active systems capable of generating, conducting and responding to measurable electrical signals.

This early bioelectric research was followed by wider investigation of biological responses to electromagnetic environments. Beverly Rubik later reviewed a body of experimental and clinical work involving Sympathetic Resonance Technology (SRT), including studies concerned with chemical and electromagnetic stress [9]. Of particular relevance to the present manuscript, Rubik's review incorporated Robert O. Young's live- and dried-blood investigations involving electromagnetic-field challenge and discussed these observations within a broader theoretical model of biological field interaction [9]. The review therefore provides a published connection between Young's earlier EMF observations, SRT/QLink research and Rubik's proposed biofield framework.

These historical lines of investigation provide an important conceptual foundation for the subsequent development of bioelectronic medicine. Contemporary bioelectronic technologies extend the study of biological electrical activity by engineering electronic interfaces capable of detecting, recording, stimulating and communicating with electrically active cells and tissues. The progression

from endogenous bioelectric signalling and experimentally investigated electromagnetic interactions to semiconductor-based biological interfaces therefore provides a conceptual bridge between the earlier work of Becker, Rubik and Young and contemporary developments in neural interfaces, biosensors, implantable bioelectronics and nanoscale electronic systems.

Development of bioelectronic medicine and semiconductor-biological interfaces

Over the past two decades, substantial advances have occurred in technologies designed to establish electrical interfaces between engineered semiconductor systems and biological tissues. The emerging discipline of bioelectronic medicine combines neuroscience, electronics, materials science, biosensing and neuromodulation to develop devices capable of recording from, stimulating or otherwise interacting with electrically active biological systems [10,11]. More recent reviews describe the progression of this field toward implantable, wearable and closed-loop systems capable of sensing physiological signals and adapting therapeutic stimulation in response to measured biological activity [12,13]. The supplied reference material specifically identifies this progression from early electroceutical concepts toward neural interfaces, implantable bioelectronics and closed-loop therapeutic systems.

A foundational technological development within this field has been the use of semiconductor nanowires as highly sensitive electrical interfaces with biological systems. Patolsky, *et al.* demonstrated high-density nanowire field-effect transistor arrays integrated with individual axons and dendrites of live mammalian neurons, enabling spatially resolved detection, stimulation and inhibition of neuronal signal propagation [14]. Semiconductor silicon nanowires have additionally been developed as electronic sensors capable of direct electrical detection of biological and chemical species [14,15]. Lieber subsequently reviewed semiconductor nanowires as a broader technological platform spanning nanoscale electronics, sensors and biological interfaces [15]. These papers provide foundational evidence for silicon-nanowire neuronal communication and semiconductor nanowires as a bioelectronic platform.

These developments progressed from individual nanoscale semiconductor interfaces toward highly flexible three-dimensional electronic networks capable of intimate integration with biological

tissue. Xie., *et al.* reported three-dimensional macroporous nano-electronic networks designed as minimally invasive brain probes, combining ultra-flexibility with subcellular-scale structural features to reduce the mechanical mismatch between conventional probes and neural tissue [16]. Related work by Hong., *et al.* described mesh electronics with tissue-like mechanical characteristics for long-term neural integration [17].

A further technological development demonstrated that flexible mesh electronics could be delivered by syringe injection. Liu., *et al.* reported syringe-injectable electronics in which macroporous mesh electronic structures could be introduced through a needle and subsequently unfold and interface with biological structures [18]. This work established that functional electronic systems do not necessarily require the form of conventional rigid surgically implanted devices; electronic architectures can instead be fabricated as highly flexible nanoscale and microscale structures capable of minimally invasive delivery and integration with tissue [16-18].

Graphene and advanced materials in neural and bioelectronic interfaces

Parallel advances in materials science have expanded the range of materials investigated for bioelectronic and neural-interface applications. Graphene and graphene-based materials have attracted substantial interest because of their electrical conductivity, mechanical flexibility, surface characteristics and potential compatibility with flexible neural-interface architectures [19]. Chemical-vapour-deposition graphene coatings have been investigated for neural interfaces, with surface chemistry, conductivity, wettability, porosity and mechanical properties evaluated in relation to neuronal attachment and function [19].

Reviews of electrode materials for brain-machine interfaces similarly describe the evolution from conventional metallic and silicon electrodes toward graphene, carbon nanotubes, conductive polymers, flexible polymer substrates and hybrid organic-inorganic materials [20]. These developments are directed toward reducing mechanical mismatch with neural tissue, improving biocompatibility, lowering electrode impedance and enhancing long-term recording stability between engineered electronic materials and neural tissue [20].

The broader field of nano-enabled neural interfaces encompasses semiconductor nanowires, graphene-based materials, car-

bon nanotubes, flexible electronics and injectable mesh electronics [21]. These technologies are characterised using complementary analytical methods including scanning electron microscopy (SEM), transmission electron microscopy (TEM), Raman spectroscopy, atomic force microscopy (AFM), X-ray photoelectron spectroscopy (XPS), energy-dispersive spectroscopy (EDS) and electrochemical analysis [20,21].

Taken together, this literature establishes an important technological context: semiconductor nanowires can electrically interface with living neurons [14,15]; flexible silicon-based nanoelectronic meshes have been developed for integration with neural tissue [16,17]; syringe-injectable electronic mesh systems have been experimentally demonstrated [18]; and graphene and related conductive materials are actively investigated as components of advanced biological and neural interfaces [19-21].

These studies demonstrate that nanoscale and flexible semiconductor-based electronic interfaces with biological tissues are established areas of contemporary materials and biomedical engineering research.

Material characterisation of graphene-silicon and related nanoelectronic structures

The identification and characterisation of nanoscale materials requires complementary analytical techniques capable of evaluating morphology, dimensions, elemental composition, crystallinity, surface chemistry and molecular structure. No single analytical technique provides all of this information; consequently, graphene, graphene oxide, silicon nanowires and related nanoelectronic materials are commonly characterised using combinations of high-resolution electron microscopy, elemental spectroscopy, surface analysis and vibrational spectroscopy [20-22].

High-resolution scanning electron microscopy (HRSEM) provides detailed imaging of surface morphology and structural organisation, while transmission electron microscopy (TEM) and high-resolution transmission microscopy (HRTEM) enable examination of nanoscale internal structure, dimensions, crystalline organisation and lattice characteristics [21-23]. These techniques have been extensively applied in the characterisation of graphene-based materials, semiconductor nanowires and nano-enabled neural-interface structures.

Energy-dispersive X-ray spectroscopy (EDS/EDX), frequently integrated with SEM or TEM instrumentation, provides elemental analysis through detection of characteristic X-rays generated during electron-beam interaction with the specimen [21-23]. The integration of high-resolution microscopy with EDS/EDX therefore enables morphological and structural observations to be considered alongside elemental composition and elemental mapping within selected regions of nanoscale materials.

Raman spectroscopy provides complementary molecular and structural information and is widely applied to graphene and graphene-derived materials. Characteristic Raman features can be used to evaluate graphene-related properties including layer characteristics, defects, disorder, strain, doping and chemical modification [19,22]. Raman spectroscopy has additionally been applied to graphene oxide, graphene nanoribbons, graphene quantum dots, chemical-vapour-deposition graphene and graphene-containing heterostructures.

Atomic force microscopy (AFM) provides nanoscale surface-topography and dimensional information and is commonly used to evaluate graphene surface morphology and material thickness, including individual and multiple graphene layers [19,20]. X-ray photoelectron spectroscopy (XPS) provides complementary information concerning surface elemental composition and chemical bonding states [19,20]. Together with electron microscopy, elemental spectroscopy and Raman analysis, these techniques enable different structural, dimensional, elemental and chemical characteristics of complex graphene- and semiconductor-associated materials to be evaluated.

The combined application of these analytical technologies is particularly important when investigating complex or hybrid nanomaterials. Reviews of nano-enabled neural interfaces and brain-machine-interface materials describe the use of SEM, TEM, Raman spectroscopy, AFM, XPS, EDS and electrochemical analysis to characterise semiconductor nanowires, graphene-based materials, flexible electronics and related neural-interface systems [20,21].

Microscopic and spectroscopic investigation of graphene-silicon-based materials

Within this analytical context, Young investigated material structures present in samples of four COVID-19 vaccines using high-resolution scanning and transmission electron microscopy

(HRSEM/HRTEM) integrated with energy-dispersive X-ray spectroscopy (EDS/XRS) [24]. According to the published report and the accompanying review summary supplied for this manuscript, these methods were used to examine nanoscale morphology and determine elemental composition within selected regions of the analysed samples.

Young reported the identification of graphene, graphene oxide (GO), silicon (Si), silicon dioxide (SiO₂), copper (Cu), copper oxide (CuO) and aluminium (Al) within the vaccine samples examined [24]. The investigation additionally employed a Cytation 5 Cell Multi-Mode Reader spectrophotometer, which Young reported as indicating high levels of graphene in all four vaccine samples [24].

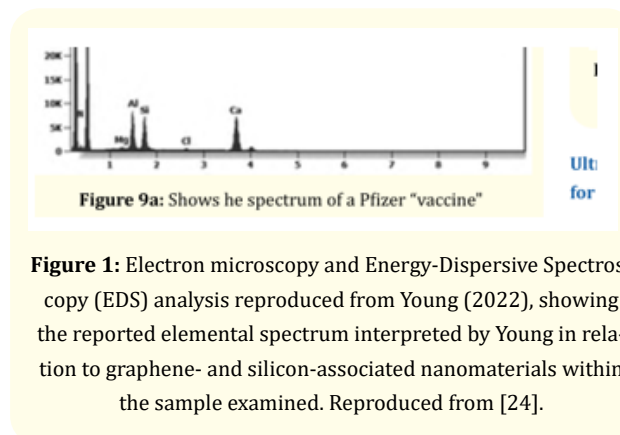


Figure 1: Electron microscopy and Energy-Dispersive Spectroscopy (EDS) analysis reproduced from Young (2022), showing the reported elemental spectrum interpreted by Young in relation to graphene- and silicon-associated nanomaterials within the sample examined. Reproduced from [24].

The analytical approach employed in Young's investigation combined high-resolution microscopy with elemental spectroscopy so that nanoscale structural morphology could be considered together with elemental composition. This combined HRSEM/HRTEM and EDS/XRS methodology is consistent with analytical approaches described in the broader literature for characterising graphene, silicon nanowires and other nano-enabled neural-interface materials [20-23].

Reviews of graphene coatings and brain-machine-interface materials similarly describe the use of Raman spectroscopy, SEM, TEM, AFM, XPS and related electrical and spectroscopic techniques to investigate surface chemistry, morphology, elemental composition, structural characteristics and material behaviour relevant to biological interfaces [19,20].

High-resolution microscopy and spectroscopy provide a complementary analytical framework through which graphene-, silicon- and related nanoscale structures can be investigated and characterised.

Biological interaction, cellular internalisation and tissue distribution

The biological behaviour of nanoscale materials depends not only upon their elemental composition, but also upon particle or sheet dimensions, morphology, surface chemistry, functionalisation, concentration and the biological environment in which exposure occurs. Graphene-based materials have consequently been investigated for their ability to interact with cellular membranes, enter or associate with cells, circulate within biological systems, and accumulate within or undergo clearance from particular tissues [25].

Experimental research has demonstrated measurable biological distribution of graphene oxide following introduction into living systems. Jasim, *et al.* investigated intravenously administered, chemically functionalised graphene oxide sheets in mice using whole-body SPECT/CT imaging, gamma counting, Raman microscopy and histological analysis [25]. The researchers reported predominant accumulation within the spleen together with extensive urinary excretion. Intact graphene oxide sheets recovered from urine were subsequently examined using Raman spectroscopy, HR-TEM and electron diffraction [25].

This investigation is particularly relevant because it demonstrates both in-vivo biological distribution and clearance of graphene oxide and the application of multiple independent analytical techniques to characterise the material following its passage through a biological system.

Silicon nanowires have similarly been investigated for their interaction with mammalian cells and tissues. Experimental studies have examined cellular internalisation, membrane interaction, cytotoxicity, pulmonary distribution and clearance of silicon nanowires [26-28]. These studies demonstrate that biological responses to silicon nanowires vary according to factors including nanowire characteristics, concentration, exposure duration and cell or tissue type.

Potential biological effects of graphene oxide and silicon nanowires

The increasing investigation of graphene-based materials and silicon nanostructures for biomedical and bioelectronic applications has been accompanied by research examining their potential biological effects. Importantly, the biological behaviour of nanoscale materials cannot necessarily be predicted solely from their elemental identity. Experimental findings indicate that responses to graphene oxide may vary according to physicochemical characteristics, oxidation state, concentration, exposure conditions and the biological environment in which the material is encountered [29-31]. The supplied literature therefore supports consideration of graphene oxide as a material whose biological effects are dependent upon both material characteristics and exposure conditions rather than as a biologically uniform substance.

Graphene oxide: Cytotoxicity and material-dependent biological responses

Lu, *et al.* investigated mechanisms underlying the cytotoxicity of graphene oxide derivatives in mammalian cells and reported that biological responses were influenced by the physicochemical characteristics of the graphene oxide materials and the conditions of exposure [29]. This work is relevant to the present discussion because it demonstrates that changes in graphene oxide structure and surface characteristics can influence its interaction with mammalian cells [29].

Zhang, *et al.* similarly investigated graphene oxide materials with differing oxidation states and reported oxidation-state- and concentration-dependent differences in cytotoxicity in mammalian cells [30]. Their findings further demonstrate that graphene oxide should not be considered a single biologically invariant material; rather, its biological activity can vary according to its physicochemical state and exposure concentration [30].

The biological environment itself may further modify these responses. Li, *et al.* investigated graphene oxide nanosheet toxicity in mice and reported that biological effects were influenced by protein-corona composition and host immune status [31]. These findings provide additional evidence that interactions between graphene oxide and biological systems may depend upon characteristics of both the material and its surrounding biological environment [31].

Oxidative stress, mitochondrial dysfunction and apoptosis

Oxidative stress has been investigated as one mechanism through which graphene oxide may influence cellular function [32,33]. Feng, *et al.* examined graphene oxide exposure in intestinal cells and reported a relationship between graphene oxide, reactive oxygen species, mitochondrial dysfunction and mitochondrial-dependent apoptosis through a ROS-p53-mPTP-associated pathway [32]. The study therefore provides mechanistic evidence connecting graphene oxide exposure under the experimental conditions investigated with oxidative stress, altered mitochondrial function and programmed cell death [32].

These findings are relevant because mitochondria are central to cellular energy metabolism, redox regulation and apoptotic signalling. Disruption of mitochondrial function through excessive reactive oxygen species can therefore provide a pathway through which nanoscale material exposure may influence cellular viability and function [32].

Genotoxicity and pulmonary effects

Potential genotoxic effects of graphene oxide have also been investigated experimentally. El-Yamany, *et al.* examined graphene oxide nanosheet exposure in mice and assessed chromosomal abnormalities, DNA damage, oxidative-stress markers and pulmonary histopathology [33]. The study reported genotoxic and pulmonary effects under the experimental exposure conditions investigated [33].

Taken together, the graphene oxide literature supplied for the present manuscript identifies several biological endpoints that have been investigated experimentally, including cytotoxicity, oxidative stress, mitochondrial dysfunction, apoptosis, genotoxicity and pulmonary injury [29-33]. Importantly, the magnitude and nature of these effects vary according to material characteristics, dose, route of exposure and biological conditions [29-33].

Biological effects and biocompatibility of silicon nanowires

Silicon nanowires occupy a particularly relevant position within this literature because the same broad class of semiconductor structures investigated for biosensing and neural-interface applications has also been evaluated for cellular interaction, internalisation, biocompatibility and potential toxicity [26-28,34]. Additional experimental work has demonstrated cellular uptake of label-free silicon nanowires across multiple cell lines, with internalisation

occurring predominantly through an endogenous phagocytic pathway [35].

Roberts, *et al.* investigated the pulmonary toxicity, distribution and clearance of intratracheally administered silicon nanowires in rats. The researchers reported dose-dependent pulmonary injury and inflammation following silicon-nanowire exposure, together with macrophage uptake and clearance. Increased lung collagen and persistence of material at later observation points were reported in the higher-exposure groups [26].

Song, *et al.* examined silicon-nanowire cytotoxicity across four mammalian cell lines and found that biological responses varied according to cell type, concentration and duration of exposure. The investigators also observed close interaction between silicon nanowires and cellular membranes, with effects upon cellular adhesion and viability under particular experimental conditions [27].

Cellular internalisation of silicon nanowires has additionally been demonstrated experimentally. Condo, *et al.* investigated cytotoxicity and internalisation of functionalised silicon nanowires and reported cellular internalisation demonstrated through confocal fluorescence microscopy [28]. Zimmerman, *et al.* similarly demonstrated spontaneous internalisation of free-standing silicon nanowires across multiple mammalian cell lines, with internalised nanowires visualised using confocal microscopy, SEM and TEM [35]. The broader biocompatibility literature reviewed by Marcon and Boukherroub further considers both *in vitro* and *in vivo* evidence concerning semiconductor silicon nanowires and their potential biological effects [34].

Collectively, these studies demonstrate the dual biological relevance of silicon nanowires. Their semiconductor and nanoscale structural properties permit intimate interaction with cells and tissues and make them useful platforms for biomedical sensing and bioelectronic interfaces; however, these same properties necessitate consideration of cellular internalisation, distribution, persistence and potential biological effects [26-28,34,35].

Radiofrequency exposure and biological effects

The potential biological significance of the present findings also requires consideration of the wider literature investigating biological responses to radiofrequency and electromagnetic-field exposure. Experimental studies have reported oxidative stress and

tissue-specific biological changes under defined RF/EMF exposure conditions, although these studies differ substantially in frequency, exposure intensity, duration, biological model and measured endpoint [36-40].

Çelik, *et al.* for example, reported increased oxidative-stress markers in brain and liver tissues following 2.45-GHz Wi-Fi exposure in an experimental rat model involving pregnancy and offspring development [36].

Güler, *et al.* investigated intrauterine and extrauterine radiofrequency exposure and reported neurodegenerative changes and apoptosis in an experimental model [37].

Odacı, *et al.* reported neuronal loss and pathological cerebellar changes following maternal exposure to a continuous 900-MHz electromagnetic field in rats [38].

Other experimental literature addresses reproductive and developmental outcomes following electromagnetic-field exposure [39], while Yakymenko, *et al.* reviewed oxidative mechanisms proposed in relation to low-intensity radiofrequency radiation [40].

These studies do not replicate the exposure conditions or measurement methodology of the present NLJD investigation. They do, however, provide a broader biological context demonstrating that interactions between electromagnetic exposures and biological systems have been investigated across oxidative, neurological, developmental and reproductive endpoints [36-40].

Young has additionally investigated biological responses associated with electromagnetic-field exposure using live and dried blood analysis [41]. In this work, blood morphology was examined in the context of an EMF-related challenge involving active and inactive devices, providing an earlier experimental context for Young's investigation of biological responses associated with electromagnetic environments [41]. This work sits alongside the wider published literature examining oxidative, neurological, developmental and reproductive responses under differing radiofrequency and electromagnetic-field exposure conditions [36-40]. Of particular relevance to the frequency range used in the present investigation, Çelik, *et al.* reported increased oxidative-stress markers in brain and liver tissues following 2.45-GHz Wi-Fi exposure in an experimental rat model involving pregnancy and offspring development [36], while other studies have investigated neurological,

developmental and reproductive responses across differing radiofrequency and electromagnetic-field exposure conditions [37-40].

Prior investigative applications of NLJD scanning in human contexts

Beyond conventional technical-surveillance applications, nonlinear junction detection and radiofrequency scanning have also been used in exploratory investigations involving human subjects. These applications have largely arisen outside formal academic research settings and have typically been undertaken by practitioners with backgrounds in technical surveillance countermeasures, radiofrequency analysis and electronic-device detection.

One such investigative context involves individuals reporting anomalous health incidents (AHIs), a term used to describe clusters of unexplained neurological and sensory symptoms that have been discussed in relation to cases commonly referred to as "Havana Syndrome." Clinical investigations have documented acute and persistent manifestations involving cognitive, vestibular, oculomotor and auditory function, together with headache and sleep disturbance [42]. A subsequent National Academies assessment described additional reported features including directional auditory phenomena, ear or head pain, sensations of head pressure or vibration, dizziness, tinnitus, visual disturbance, vertigo, cognitive difficulties and, in some cases, nausea [43]. Multiple mechanisms have been considered, but the underlying cause of these incidents has not been definitively established [43].

Mind Nexus (Cosmic Clarity Connections LLC) has reported using radiofrequency and nonlinear junction detection instrumentation in exploratory human investigations. Its described procedures include RF scanning and use of the EDD-24XT NLJD to identify and document nonlinear harmonic responses detected on or around a person [44]. These procedures are presented as investigative rather than medical diagnostic assessments [44].

Although such activities have generated observational and case-based material, they remain largely undocumented within peer-reviewed scientific literature. Consequently, questions concerning the prevalence, spatial distribution, intensity and temporal behaviour of second-harmonic-dominant NLJD detections in human subjects have not been systematically addressed within structured cohort-based study designs.

Additional case-based observations have contributed to interest in whether anatomically localised NLJD responses may correspond to physical structures within the body. One example is the Bonnie Kellerby case, in which investigators reported localised electronic and nonlinear-junction detections at anatomical sites subsequently associated with surgically removed material. In a 2018 Phase I report, Staninger documented photomicrographic examination of three specimens associated with Kellerby and described morphological features that she interpreted as including fibre- or antenna-like structures, micro-array patterns and integrated-circuit-like architectures [45].

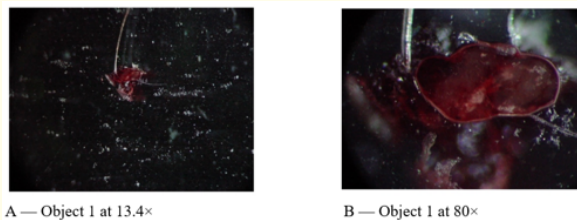


Figure 2: Photomicrographic examination of surgically removed material associated with the Bonnie Kellerby investigation. (A) Representative overview of Object 1 at 13.4x magnification and (B) corresponding higher-magnification view at 80x. The specimen was documented in Staninger’s Phase I report and was subsequently selected for SEM/EDS and Raman/Micro-FTIR characterisation described in the Phase II/III report [45,46]. The images document the morphology of the recovered material; morphological appearance alone does not establish its chemical composition, electronic properties or technological function.

Reproduced from Staninger [45], with permission.

A subsequent Phase II/III report described further materials characterisation of Object 1, a specimen reported as having been removed from the left posterior neck, using scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM/EDS) and Raman/Micro-FTIR spectroscopy [46]. Staninger interpreted the combined morphological, elemental and spectroscopic findings within a framework of implantable biosensory and semiconductor-related technology [46]. These interpretations should be distinguished from the analytical observations themselves: photomicrographic morphology and compositional or spectroscopic measurements do not, independently, establish the technological function of a recovered structure.

The Kellerby investigation is therefore relevant to the present study as an earlier case-based example in which anatomically localised electronic detections were reportedly followed by physical recovery and laboratory examination of material from corresponding anatomical regions [45,46]. Because these observations and subsequent interpretations have not been reported within a peer-reviewed controlled study, they are presented here as contextual investigative evidence rather than as validation that an NLJD response identifies a particular implanted material or structure.

These prior investigative observations nevertheless provide an important historical bridge between the established use of NLJD technology for detecting nonlinear electronic responses and the present attempt to apply a structured, reproducible scanning protocol to a general-population cohort. The current investigation was designed not to infer the physical identity of the source responsible for a detected response, but to determine whether second-harmonic-dominant NLJD signals could be reproducibly detected, anatomically mapped and quantitatively followed over time under standardised conditions.

Wireless body area networks and bioelectronic communication

The development of implantable, wearable and tissue-integrated bioelectronic technologies has occurred alongside advances in Wireless Body Area Networks (WBANs), which enable short-range communication between sensors, actuators and electronic devices positioned on, within or in the immediate vicinity of the human body. The IEEE 802.15.6 standard specifically defines short-range wireless communication in the vicinity of, or inside, the human body, incorporating requirements for low-power operation, quality of service and reliable data transmission [47]. Takizawa, *et al.* further characterised radio-propagation channels for WBAN applications using wearable sensors positioned in relation to the human body, providing an experimental engineering basis for communication between body-associated electronic devices [23].

Within biomedical engineering, WBANs may incorporate wearable or implanted sensors capable of acquiring physiological information and communicating that information through a coordinating device or gateway to external systems. Mansfield describes this progression as an ‘information pathway’ through which biological or physiological signals can be sensed at the body, converted into electronic data and transmitted beyond the original sensing loca-

tion. Published WBAN architectures describe physiological data being collected by body-associated nodes, transmitted to a personal server or gateway and subsequently transmitted through the Internet to remote servers capable of processing, analysing and storing that information [48,49]. This establishes an information pathway extending from the human body through wireless communication to external computing, cloud/server and data-centre infrastructure.

A contemporary example of this information pathway is described in Apple Inc. patent application US 2023/0225659 A1, Bio-signal Sensing Device Using Dynamic Selection of Electrodes. The patent describes wearable electrodes capable of acquiring biological electrical signals, including electroencephalographic (EEG) activity, together with electromyography (EMG), electrooculography (EOG), electrocardiography (ECG), galvanic skin response (GSR) and blood-volume pulse (BVP). The described architecture permits acquired biosignals to be amplified, digitised and transmitted wirelessly to user equipment through Bluetooth or Wi-Fi. The patent further describes data transmission from the user equipment to a server using communications technologies including 3G, 4G, 5G, 6G, Wi-Fi and WiMAX, with measurements capable of being retained by the server as historical data [50]. The patent therefore provides a documented example of an information pathway extending from biological electrical activity at the human body through sensing, digitisation and wireless data transmission to external server infrastructure.

The technological pathway extends further into brain-computer interfacing and neural-signal decoding. Meta Platforms patent US 11,301,044 B1, Wearable Brain Computer Interface, describes a head-worn BCI using light sources and optical detectors to characterise brain activity, with decoded brain activity capable of becoming an input for controlling other systems or electronic content. The architecture incorporates power and computing electronics and describes the BCI as supporting unspoken communication [51].

A related Meta Platforms patent, US 11,314,329 B1, Neural Decoding with Co-Learning for Brain Computer Interfaces, provides a signal-processing and artificial-intelligence decoding stage in which a neural-signal stream is processed to predict user actions or intentions. The specification describes actual and imagined motor activity and the conversion of decoded neural signals into commands capable of interaction with physical or virtual objects [52].

Taken together, Young considers these Meta patents to establish a progression from brain-wave activity through optical sensing and signal acquisition to neural decoding, predicted intent or action and interaction with external electronic systems. The patent itself describes decoding light-derived signals to extract predicted user actions or intents.

A further technological example is provided by Neurable Inc. patent US 11,609,633 B2, Monitoring of Biometric Data to Determine Mental States and Input Commands. The described architecture uses electrodes within headphones to detect neural and muscle signals, with an Analytics Engine preprocessing the signals, extracting features and supplying those features to machine-learning models. Outputs may represent inferred mental states or gestures used as computer commands. The disclosure further contemplates the Analytics Engine operating on a smartphone, tablet or laptop, within a cloud-based computing system, or distributed between the headphones, a personal computing device and the cloud, and describes Bluetooth communication between the headphones and a smartphone [53]. The patent documentation describes machine-learning analysis of headphone-derived neural-signal data to infer mental states or input commands.

Within Young's synthesis, this provides a documented technological pathway approximating: EEG/EMG activity → headphones/electrodes → Bluetooth/device → feature extraction → artificial intelligence or machine-learning analysis → mental-state inference → smartphone/computer/cloud-based processing and subsequent computer action [53].

The significance of WBAN technology extends beyond conventional external wearable sensors. Contemporary bioelectronic medicine encompasses implantable and tissue-interfacing systems capable of recording physiological electrical activity, delivering stimulation and operating within closed-loop architectures in which biological information can be sensed, processed and used to modify subsequent device activity [12,13]. At the material and device level, semiconductor nanowires, flexible and injectable mesh electronics and graphene-associated interfaces provide experimentally demonstrated technologies capable of establishing intimate electrical contact with biological systems [14-22]. At the communications level, WBAN and miniaturised wireless bioelectronic technologies provide mechanisms through which information originating at body-associated electronic interfaces can be transmitted beyond the original sensing location [23,47-50].

The wider Internet of Things (IoT) extends this information pathway by connecting distributed sensors and electronic systems with external communications and computing infrastructure. In established WBAN architectures, a body-area network can therefore represent the first stage of a wider data-transmission chain: physiological or neural signal acquisition at the body → electronic sensing and digitisation → signal processing and feature extraction → short-range wireless transmission → coordinating device or gateway → external computing and artificial intelligence or machine-learning analysis → Internet/cloud communication → remote processing, data storage and data-centre infrastructure [48-53].

Taken together, Young considers the published bioelectronic literature, WBAN architectures and patent documentation to support a wider technological chain of human or animal tissue → bioelectrode, biotransistor or sensor → analogue amplification → digitisation → wireless link → external computer → signal processing or artificial intelligence → cloud/networked processing and data storage. Young's proposed framework similarly places neural/physiological sensing, signal acquisition, feature extraction, AI/machine-learning decoding, wireless communication, external computing and cloud/networked storage within this wider technological pathway.

Within Young's proposed GrapHene Oxidative Silicon Technology (GHOST™) framework, these technologies are considered interconnected components of a wider information and data-transmission pathway linking biological sensing with external computational systems.

Rationale and objectives of the present study

Taken together, the preceding literature establishes several distinct but potentially interconnected lines of scientific and technological evidence. Semiconductor nanowires have been developed to establish electrical interfaces with living cells and neurons [14-16], while flexible, injectable and tissue-like mesh electronic architectures have demonstrated integration of nanoscale electronic systems with biological tissues [17-22]. Graphene and graphene-derived materials have additionally been investigated as conductive and mechanically flexible components of neural and biological interfaces [19,21,22].

As described earlier, Young's previous SEM, TEM and EDS/EDX analyses reported graphene- and silicon-associated signatures

within materials examined from COVID-19 vaccine samples [24]. These analytical observations, considered alongside the wider literature concerning graphene-silicon nanomaterials, bioelectronic interfaces and biological interaction, contributed to the subsequent development of Young's proposed GrapHene Oxidative Silicon Technology (GHOST™) framework.

Experimental biological studies have additionally demonstrated cellular interaction and internalisation of silicon nanowires and investigated the distribution, clearance and biological effects of graphene oxide and silicon nanostructures [25-35]. Separately, experimental RF/EMF literature has investigated oxidative, neurological, reproductive and developmental biological effects under a range of defined exposure conditions [36-41].

Together with the preceding literature concerning nanoscale bioelectronic interfaces, Wireless Body Area Networks (WBANs), brain-computer interfaces, neural-signal decoding, artificial intelligence and external/cloud-based processing [47-53], these fields provide the technological and biological context within which Young's proposed GHOST™ framework is considered in the present investigation.

Alongside this peer-reviewed scientific literature, exploratory human investigations using RF and NLJD instrumentation have reported anatomically localised second-harmonic-dominant responses in individuals, including investigations undertaken in the context of anomalous health incidents. However, these observations have largely remained case-based and have not established the prevalence, anatomical distribution or temporal behaviour of the phenomenon within a structured general-population cohort.

The present study was therefore undertaken to determine whether second-harmonic-dominant nonlinear responses could be systematically detected and anatomically mapped in human participants using a standardised NLJD scanning protocol, and whether those measured responses changed over a defined 63-day period during daily supplementation with a nano-sized clinoptilolite-based formulation.

The primary objectives were:

- To determine the prevalence of second-harmonic-dominant NLJD responses within the 22-person study cohort;

- To map the anatomical distribution and number of discrete Active Signal Spots detected in each participant;
- To quantify the aggregate magnitude of those responses using Signal Intensity Score;
- To compare baseline and 63-day measurements under standardised scanning conditions; and
- To evaluate whether the number, cumulative Signal Intensity Score and Mean Signal Intensity per Detection Site changed during the defined 63-day intervention period.

Methods
Study design

This exploratory pre-post cohort study evaluated the presence, anatomical distribution and temporal behaviour of second-harmonic-dominant nonlinear junction detector (NLJD) responses in adult human participants over a 63-day period.

Participants underwent a standardised baseline full-body NLJD assessment prior to commencement of the intervention. Following baseline assessment, participants undertook a defined daily supplementation protocol using MasterPeace® Zeolite-Z® for 63 days, after which the NLJD assessment was repeated using the same instrument, operator, testing location and scanning procedure.

The primary analytical measures were: (1) the number of discrete anatomical locations demonstrating qualifying second-harmonic-dominant responses, defined as Active Signal Spots; (2) the cumulative Signal Intensity Score, calculated for each participant by summing the individual Signal Intensity values across all Active Signal Spots; and (3) Mean Signal Intensity per Detection Site, calculated by dividing the participant’s Signal Intensity Score by the corresponding number of Active Signal Spots. Individual Signal Intensity values recorded at each detected location provided the underlying measurements from which the latter two measures were derived.

The study was designed to determine whether these NLJD-derived signal measures changed between baseline and follow-up.

Participant recruitment and selection

Participants were recruited as adult volunteers from the general population for an exploratory cohort investigation of second-harmonic-dominant NLJD responses. Recruitment was not tar-

geted towards any specific occupational, military, diplomatic or industrial exposure group.

Inclusion criteria consisted of adults aged 25 years or older who voluntarily consented to participate in both baseline and follow-up assessments and agreed to comply with the study procedures throughout the 63-day observation period.

Participants with implanted electronic medical devices or other known electronic implants—including pacemakers, cochlear implants and neurostimulators—were excluded because semiconductor-containing medical devices could produce nonlinear junction responses and therefore potentially confound the measurements obtained during scanning. Participants unable to complete both assessments were excluded from the final comparative analysis.

Participants were not selected according to pre-existing medical diagnosis, vaccination status, occupational background or assumptions concerning previous environmental or technological exposure.

The final cohort consisted of 22 participants, comprising 12 females and 10 males aged 26-75 years.

Participants were categorised into the following age groups: 26-35, 36-45, 46-55, 56-65, 66-75 years. Participant distribution by age group and sex is shown in Table 1.

Age Category (years)	Female (n)	Male (n)	Total (n)
26-35	3	2	5
36-45	0	3	3
46-55	4	1	5
56-65	5	2	7
66-75	0	2	2
Total	12	10	22

Table 1: Participant demographics.

NLJD instrumentation

NLJD assessments were performed using an EDD-24XT Portable Non-Linear Junction Detector (JJN Digital, Cheltenham, United Kingdom) [3].

The EDD-24XT operates using a 2.4-GHz radiofrequency excitation signal and monitors nonlinear harmonic responses at the corresponding second and third harmonics, 4.8 GHz and 7.2 GHz, respectively [55]. The instrument is designed to detect nonlinear electrical junctions associated with semiconductor-containing electronic components. According to the manufacturer, semiconductor electronics incorporating silicon produce a strong second-harmonic response when exposed to the transmitted high-frequency signal, whereas materials including some bi-metals and oxidised metals may produce a stronger third-harmonic response [54,55].

The EDD-24XT incorporates an algorithm that analyses the detected responses from the second- and third-harmonic receivers and provides an instrument classification indicating the probability of the detected material as “Silicon” or “Metal” [55].

According to the manufacturer’s technical documentation, the instrument incorporates internal automatic tuning and signal optimisation during power-up and operation to adapt to the surrounding electromagnetic environment [55]. No separate user-performed laboratory calibration procedure was therefore undertaken immediately before participant scanning; the instrument was powered on and permitted to complete its standard internal adjustment procedure before each testing session.

For the purposes of the study, detections displaying the instrument’s second-harmonic-dominant classification described as “Probability Silicon” were recorded as signals consistent with synthetic silicon-based electronic circuitry. This terminology refers to the harmonic response classification displayed by the instrument and does not constitute direct elemental identification of silicon or another material.

Radiofrequency environment and control of potential interference

All baseline and follow-up assessments were conducted in the same indoor testing location by the same independent TSCM-certified specialist investigator using the same EDD-24XT instrument. Participants were scanned individually.

Before scanning, participants removed metallic jewellery, mobile phones, smart watches, smart devices and other electronic items from their person to minimise potential interference or external nonlinear junction responses within the detection range of the probe.

Standard background building infrastructure, including mains electricity, lighting and routine wireless signals present within the surrounding environment, was not eliminated. However, no intentional RF-emitting device was operated in close proximity to participants during active scanning.

Common dental restorations, including fillings, crowns and dental implants, were not exclusionary. Participants with known implanted electronic medical devices capable of generating nonlinear-junction responses, including pacemakers, cochlear implants and neurostimulators, were excluded as described above.

Standardised Full-Body NLJD scanning procedure

Each participant underwent a systematic full-body assessment using the EDD-24XT Portable Non-Linear Junction Detector. The same standardised scanning procedure was applied to all participants at baseline and repeated at the 63-day follow-up assessment.

Before each assessment, the EDD-24XT was powered on and allowed to complete its internal environmental signal-adaptation and self-tuning procedure. The investigator then moved the NLJD probe systematically across successive anatomical regions of the participant at close proximity to the body. This permitted localisation of individual nonlinear responses and association of each qualifying detection with the anatomical region immediately adjacent to the probe at the time of detection.

For each anatomical region, the investigator monitored the relative second- and third-harmonic responses displayed by the EDD-24XT. A detection was recorded when a localised second-harmonic-dominant response meeting the predefined study criteria was identified.

The instrument classification “Probability Silicon” was used operationally to identify the second-harmonic-dominant response pattern of interest. Within the study dataset, these responses were recorded as signals consistent with synthetic silicon-based electronic circuitry on the basis of the instrument’s harmonic classification.

Anatomical localisation and mapping of active signal spots

An important component of the study methodology was the spatial localisation of individual NLJD detections.

Each discrete anatomical location demonstrating a qualifying second-harmonic-dominant response was designated an Active Signal Spot. Rather than recording only whether a participant produced an overall NLJD response, the location and relative intensity of each individual detection were documented so that the spatial distribution of responses could be evaluated within each participant and across the cohort.

During scanning, the independent investigator operated the EDD-24XT while a trained assistant contemporaneously documented the observations. When an Active Signal Spot was detected, the investigator identified its anatomical location and verbally reported the numerical Signal Intensity value displayed by the instrument.

The assistant recorded each detection on a standardised anatomical body schematic using the appropriate anterior or posterior body view and entered the corresponding Signal Intensity value adjacent to the marked location.

This produced an individual anatomical signal map for each participant at each assessment.

The same anatomical scanning procedure was repeated at the 63-day follow-up. Baseline and follow-up body maps could therefore be compared to determine whether previously identified Active Signal Spots remained detectable, whether their recorded Signal Intensity changed, and whether the overall number and distribution of detectable locations changed during the observation period.

Raw data recording and transfer

Because the EDD-24XT does not internally store individual participant scan measurements, raw observations were recorded manually during each assessment.

For each participant and assessment, the raw record therefore contained:

- The anatomical position of each Active Signal Spot;
- Whether the location was recorded on the anterior or posterior body surface;
- The numerical Signal Intensity recorded at each location; and

- The total number of Active Signal Spots identified during the full-body scan.

Following completion of the assessments, the manually recorded anatomical and numerical data were transferred into spreadsheet format for compilation and cohort-level analysis.

The original anatomical maps were retained as the spatial record of the individual detections, while the compiled numerical dataset was used to calculate participant-level and cohort-level outcome measures.

Definition and quantification of NLJD signal metrics

Three principal NLJD-derived metrics were used: Active Signal Spots, Signal Intensity Score and Mean Signal Intensity per Detection Site. Individual Signal Intensity values recorded at each Active Signal Spot provided the underlying measurements used to derive the latter two metrics.

Active Signal Spot was defined as a discrete anatomical location demonstrating a second-harmonic-dominant NLJD response meeting the study detection criteria.

Signal Intensity was defined as the numerical detection value recorded from the EDD-24XT at each Active Signal Spot, representing the relative magnitude of the harmonic response at that location.

Signal Intensity Score was calculated for each participant as the sum of the Signal Intensity values recorded across all Active Signal Spots identified during that assessment:

Signal Intensity Score = Σ Signal Intensity of all Active Signal Spots

This provided a participant-level measure of cumulative recorded harmonic response magnitude across all detected Active Signal Spots.

A further derived measure, Mean Signal Intensity per Detection Site, was calculated by dividing each participant's total Signal Intensity Score by the corresponding number of Active Signal Spots:

Mean Signal Intensity per Detection Site = Signal Intensity Score $\div$ Active Signal Spots

This measure was used to distinguish changes in the number of detectable anatomical sites from changes in the average intensity of the responses remaining detectable.

Intervention

Clinoptilolite composition and distinction between silicon, silica, and silicone

Natural clinoptilolite is a crystalline hydrated aluminosilicate belonging to the zeolite group of minerals. Its three-dimensional framework consists predominantly of interconnected silicon-oxygen (SiO_4) and aluminium-oxygen (AlO_4) tetrahedra, producing an ordered microporous structure containing channels and cavities occupied by water molecules and exchangeable cations [56-59].

Pabiś-Mazgaj, *et al.* characterised clinoptilolite powders obtained from zeolite-rich tuffs using complementary mineralogical and structural analytical methods, examining their mineralogical composition, crystal structure, morphology, particle-size distribution and textural properties [56]. This reference is particularly relevant to the present study because it provides direct material-characterisation evidence for natural clinoptilolite of the type forming the mineral basis of the intervention.

Substitution of aluminium for silicon within the tetrahedral framework generates a net negative structural charge. This charge is balanced principally by exchangeable cations including sodium (Na^+), potassium (K^+), calcium (Ca^{2+}) and magnesium (Mg^{2+}), which occupy the channels and cavities of the zeolite structure [57-59]. These exchangeable cations contribute to the characteristic cation-exchange capacity of clinoptilolite, while its organised microporous framework contributes to its adsorption and molecular-sieving properties [57-59].

An important distinction must be made between the silicon naturally present within clinoptilolite and the semiconductor silicon discussed elsewhere in this manuscript. Within clinoptilolite, silicon, aluminium and oxygen form part of the naturally occurring crystalline aluminosilicate framework [56-59]. This framework-bound silicon is chemically and structurally distinct from elemental semiconductor silicon and engineered silicon nanowires used in electronic and nanoelectronic technologies [14-16]. The presence of silicon within clinoptilolite should therefore not be interpreted as indicating that clinoptilolite possesses the same composition,

structure or electronic function as the silicon-based semiconductor materials considered in relation to the NLJD findings.

The terminology surrounding silicon-containing materials requires particular clarification in the context of the present study because silicon, silica, silicone and clinoptilolite are chemically and structurally distinct materials.

Silicon (Si) is a chemical element with atomic number 14. Elemental silicon is a semiconductor and is extensively utilised within conventional electronics, semiconductor devices, silicon nanowires and nanoelectronic technologies [14-16].

Silica, or silicon dioxide (SiO_2), is a compound composed of silicon and oxygen. It occurs naturally in minerals and materials including quartz and sand and forms part of the chemical framework of many naturally occurring silicate and aluminosilicate minerals.

Silicone refers to a family of synthetic silicon-containing polymers characterised principally by repeating siloxane (Si-O-Si) backbones with organic side groups. Silicones are chemically distinct from both elemental silicon and naturally occurring silica.

Clinoptilolite, by comparison, is neither elemental semiconductor silicon nor a silicone polymer. It is a naturally occurring crystalline hydrated aluminosilicate mineral whose framework contains silicon, aluminium and oxygen together with exchangeable cations and structural water [56-59].

This distinction is particularly important within the present investigation because the occurrence of silicon and oxygen within the natural aluminosilicate framework of clinoptilolite should not be interpreted as making the mineral chemically or functionally equivalent to elemental silicon semiconductor structures, silicon nanowires, synthetic silicone polymers or isolated silica.

Physicochemical properties of clinoptilolite relevant to the intervention

The physicochemical behaviour of clinoptilolite is principally determined by its crystalline aluminosilicate framework, internal channel system, surface characteristics and exchangeable cations [57-59]. Its negatively charged framework enables ion-exchange interactions with positively charged ionic species, while its internal pore architecture contributes to selective adsorption according

to factors including molecular dimensions, charge, hydration and affinity for the zeolite surface [57-59].

These properties have resulted in extensive investigation of natural and modified clinoptilolite for adsorption and ion-exchange applications [57-59]. Reviews of clinoptilolite used in biological contexts have additionally examined its physicochemical characteristics, processing, safety and proposed applications [58,59].

For the present study, these established physicochemical characteristics provide the material-science rationale for the selection of natural clinoptilolite as the principal mineral component of the intervention. The study itself, however, did not directly measure adsorption, ion exchange or binding of a particular substance during the 63-day intervention; its measured outcomes were the NLJD-derived signal parameters defined above.

Intervention formulation and administration

The intervention used in the present study was MasterPeace® Zeolite-Z®, described in the study documentation as a liquid colloidal formulation of nano-sized natural clinoptilolite Zeolite-Z® suspended in structured isotonic natural sea mineral plasma (SO-Lergy®).

Participants were instructed to self-administer 15 drops orally twice daily for 63 days.

Participants were asked to maintain their usual dietary, lifestyle and supplementation practices throughout the study period to minimise intentional changes in other variables.

Adherence was assessed by participant self-report at follow-up. Most participants reported adherence to the full dosing protocol. One participant reported taking a reduced dose and one reported missing approximately 5-7 days of supplementation during the study period. No other protocol deviations were recorded.

Three participants had previously used the intervention during an earlier exploratory investigation approximately six months before the present study. Two had continued supplementation between studies, whereas one had discontinued following the earlier investigation. These participants were retained within the present cohort to permit exploratory observation of signal characteristics in participants with differing prior exposure histories.

Statistical analysis

Baseline and follow-up measurements were compiled for each participant across the 63-day observation period.

Primary analytical variables comprised Signal Intensity Score, number of Active Signal Spots and Mean Signal Intensity per Detection Site.

For each participant, baseline and follow-up values were recorded and percentage change over time was calculated. Descriptive statistics included means, medians, ranges and cohort-level percentage change.

Within-subject changes between baseline and follow-up were evaluated descriptively. Given the exploratory study design and relatively small cohort, analyses were interpreted primarily descriptively, with emphasis placed upon the direction, consistency and magnitude of observed change.

Ethical considerations and adverse-event monitoring

All participants voluntarily provided informed consent before inclusion and were informed of the study procedures, exploratory nature of the investigation and their right to withdraw. Participant data were anonymised before analysis and reporting.

Participants were asked to report unexpected symptoms, adverse effects or health concerns arising during the study period, and reports were documented where applicable.

Prior human analytical evidence and intervention rationale

Previously published three-person pilot study

Prior to the present investigation, Young and Mansfield conducted a 90-day exploratory pilot study examining intracellular measurements of selected environmental compounds in three adult participants during daily supplementation with MasterPeace® Zeolite Z®. The study was subsequently published in *Acta Scientific Medical Sciences* in 2024 [60].

The pilot employed a pre-test/post-test design in which venous blood samples were collected at baseline, Day 35 and Day 90. Participants received a minimum dosage of five drops of MasterPeace® Zeolite Z® twice daily for the duration of the study [60].

Blood samples were analysed by IGL-Labor GmbH, Germany, using the intracellular electrical capacity (iEC) Cellular Toxin Examination. The published study describes the assay as evaluating intracellular measurements in lymphocytes, with results reported in nanomoles per litre (nmol/L) [60].

Five analytes were initially assessed at baseline: graphene oxide (2D Nano), polyethylene (PE), polypropylene (PP), perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). At Day 35, five additional analytes—aluminium, glyphosate/AMPA, iron, lindane and phosgene—were incorporated into the analytical panel [60].

Of particular relevance to the present investigation was the inclusion of graphene oxide (2D Nano) among the original analytes measured from baseline. Measurements were available at all three assessment points and demonstrated a progressive reduction across the 90-day observation period, with mean measured graphene oxide decreasing by approximately 72% from baseline to Day 90 [60].

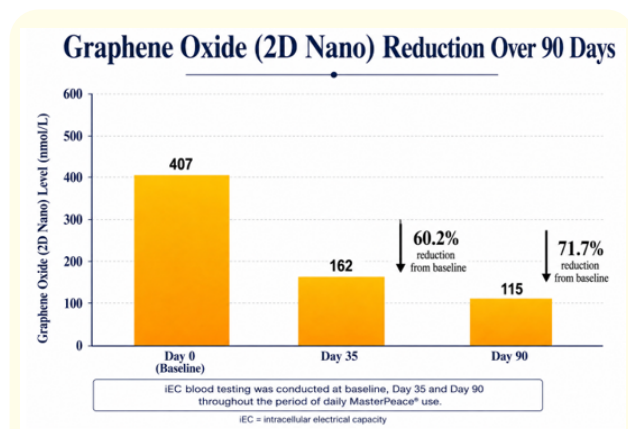


Figure 3: Graphene Oxide (2D Nano) iEC Measurements in the Previously Published Three-Participant Pilot Study at Baseline, Day 35 and Day 90. Mean cohort measurements at each assessment point are shown. Data derived from a previously published pilot study [60].

Across the 90-day observation period, the published study reported reductions in the measured analytes, with measurements at Day 90 reported within the study's defined borderline or tolerable ranges [60].

The pilot was exploratory and did not include a control group. Its principal limitations included the sample size of three participants, their relatively similar ages and the 90-day study duration. The authors therefore identified the need for subsequent investigation in a larger and more diverse population [60].

Subsequent 24-Participant iEC baseline assessment

Following the pilot investigation, the research programme was expanded to a larger 24-participant controlled study, from which findings have subsequently been published. As part of that investigation, all 24 participants underwent baseline iEC assessment across an expanded 27-analyte panel. The complete baseline 27-analyte dataset was not included in the subsequent publications and is presented here to provide additional analytical context for the present investigation.

The resulting dataset provided a broader profile of the compounds reported by the assay before intervention.

The panel encompassed multiple analytical categories, including heavy metals, plastics and synthetic polymers, PFAS, agricultural and industrial chemicals, radionuclides, biological toxins, halogens and materials categorised in the dataset as having engineered-material or bioelectronic applications.

The 27 baseline analytes comprised polypropylene (PP), arsenic, fluoride, glyphosate/AMPA, lead, iron, plutonium-239, titanium dioxide, inorganic mercury, barium, aluminium, *Aspergillus parasiticus*, methylmercury, ethylmercury (thimerosal), aluminium salts, bisphenol-A (BPA), PFOS, polyethylene (PE), PET, graphene oxide (GO), phosgene, chlorine, PFOA, dioxane, PEG-2000 compound, caesium-137 and atrazine.

The ranked baseline values ranged from 8,504.6 nmol/L cumulatively for polypropylene to 5,393.1 nmol/L for atrazine. Of particular relevance to the technological and material-science framework of the present paper, graphene oxide (GO) was included among the 27 measured analytes and produced a cumulative baseline concentration of 6,794.8 nmol/L across the 24-participant cohort. Titanium dioxide and PEG-2000 were also represented within the expanded analytical panel.

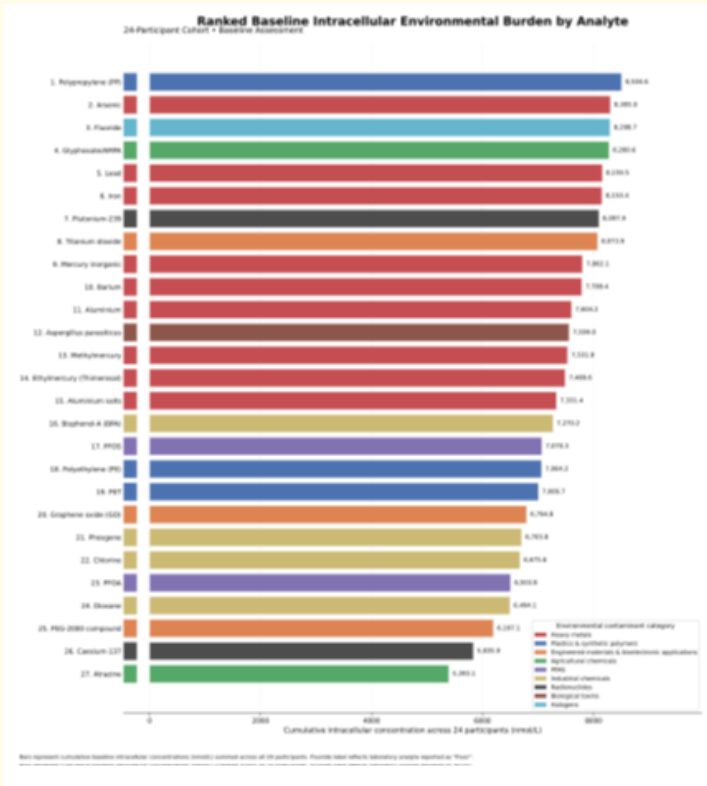


Figure 4: Ranked Baseline Intracellular Environmental Burden by Analyte in the Separate 24-Participant Cohort. The figure presents the cumulative baseline intracellular concentrations, expressed in nmol/L and summed across all 24 participants, rather than individual participant means.

Longitudinal iEC reassessment had been planned for the 24-participant cohort; however, follow-up iEC testing could not be completed because the laboratory subsequently ceased providing the assay. Consequently, the iEC dataset available from this cohort comprises the baseline measurements across the 27-analyte panel only. These data are therefore presented in the present paper solely as baseline analytical observations and should not be interpreted as evidence of longitudinal change within the 24-participant cohort.

Relevance of the prior analytical findings to the present NLJD investigation

The preceding studies provide an analytical context for the present investigation but represent separate participant cohorts and a different measurement methodology.

The published three-participant pilot provided longitudinal iEC measurements of graphene oxide and other selected analytes across a 90-day intervention period [60], while the subsequent 24-participant investigation provided a broader baseline iEC profile encompassing 27 measured analytes. Although the wider 24-participant investigation incorporated additional analytical methodologies and longitudinal assessments, longitudinal reassessment using the iEC assay itself could not be completed following discontinuation of the laboratory service. The present 22-participant study did not employ iEC testing and should therefore not be interpreted as a direct replication or extension of those intracellular measurements.

Rather, the earlier findings contributed to the rationale for investigating a distinct and independently measurable phenomenon:

Citation: Robert O Young and Caroline Mansfield. "Graphene Oxidative Silicon Technology (GHOST™) Found in Human Tissues and Removed by Mineralised Nano-Sized Clinoptilolite". *Acta Scientific Medical Sciences* 10.10 (2026): 46-83.

anatomically localised, second-harmonic-dominant nonlinear responses detected using NLJD instrumentation.

This distinction is fundamental to the study design. The iEC assay and NLJD assessment measure different parameters and cannot be considered interchangeable. The previous iEC investigations provide contextual analytical evidence concerning compounds reported within separate human cohorts, whereas the present study evaluates whether the number, anatomical distribution and intensity of NLJD-detectable Active Signal Spots changed during a defined 63-day intervention period.

Accordingly, the present investigation extends the research programme into a different analytical domain, moving from laboratory-based intracellular measurements of selected analytes to quantitative assessment and anatomical mapping of nonlinear harmonic responses in human participants.

Results

Participant Completion and Adherence

All 22 participants included in the study completed baseline and 63-day follow-up NLJD assessments and were included in the comparative analysis.

The final cohort comprised 12 females and 10 males aged 26-75 years. Most participants reported adherence to the prescribed intervention of 15 drops twice daily throughout the 63-day study period. One participant reported taking a reduced dose, while one participant reported missing approximately 5-7 days of supplementation. No participants were excluded from the final analysis on the basis of these deviations.

Overall change in NLJD signal parameters

Substantial reductions were observed across all three principal NLJD-derived outcome measures between baseline and Day 63.

The cohort mean Signal Intensity Score decreased from approximately 1,340 at baseline to 277 at Day 63, representing an overall reduction of approximately 79%.

The mean number of anatomically localised Active Signal Spots decreased from approximately 21 per participant at baseline to 7 at Day 63, representing an overall reduction of approximately 67%.

The Mean Signal Intensity per Detection Site also decreased, from approximately 64 at baseline to 40 at Day 63, corresponding to an overall reduction of approximately 38%.

Together, these findings indicate that the reduction in cumulative Signal Intensity Score reflected both a substantial reduction in the number of anatomically detectable signal locations and a reduction in the average intensity of those locations that remained detectable.

NLJD parameter	Baseline mean	Day 63 mean	Approximate change
Signal Intensity Score	1,340	277	-79%
Active Signal Spots	21	7	-67%
Mean Signal Intensity per Detection Site	64	40	-38%

Table 2: Cohort-Level Change in NLJD Parameters from Baseline to Day 63.

Change in cohort mean signal intensity score

The cohort mean Signal Intensity Score decreased from approximately 1,340 at baseline to 277 at Day 63, representing an overall reduction of approximately 79%.

The Signal Intensity Score represents the cumulative intensity of all qualifying Active Signal Spots detected within each participant. This reduction reflects a substantial decrease in the cumulative NLJD-detectable signal activity recorded across the 63-day study period.

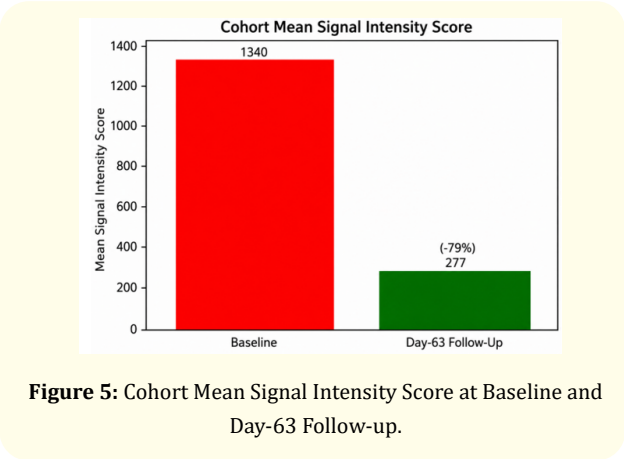


Figure 5: Cohort Mean Signal Intensity Score at Baseline and Day-63 Follow-up.

Change in cohort mean active signal spots

At baseline, participants demonstrated multiple discrete anatomical locations producing qualifying second-harmonic-dominant NLJD responses. The cohort mean number of Active Signal Spots decreased from approximately 21 per participant at baseline to 7 at Day 63, representing an approximate 67% reduction.

This finding demonstrates that the reduction in cumulative Signal Intensity Score was accompanied by a substantial reduction in the number of anatomical locations at which qualifying NLJD responses remained detectable.

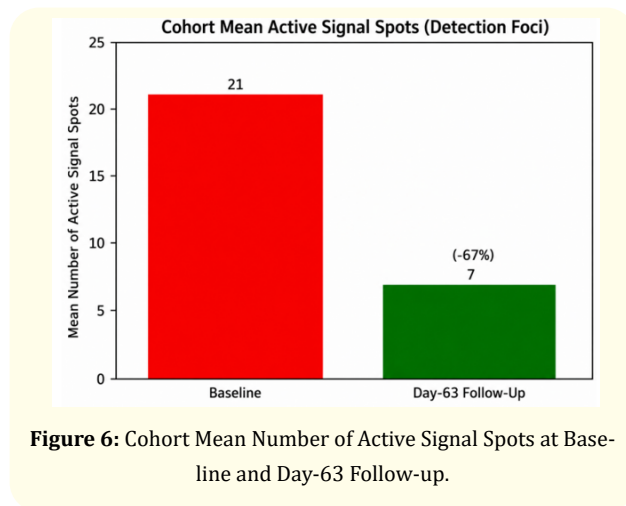


Figure 6: Cohort Mean Number of Active Signal Spots at Baseline and Day-63 Follow-up.

Change in mean signal intensity per detection site

In addition to the reduction in the number of Active Signal Spots, the mean intensity of the responses remaining detectable also decreased.

Mean Signal Intensity per Detection Site decreased from approximately 64 at baseline to 40 at Day 63, representing an approximate 38% reduction.

The concurrent reduction in both the number of Active Signal Spots and the mean Signal Intensity per Detection Site contributed to the larger overall reduction observed in cumulative Signal Intensity Score.

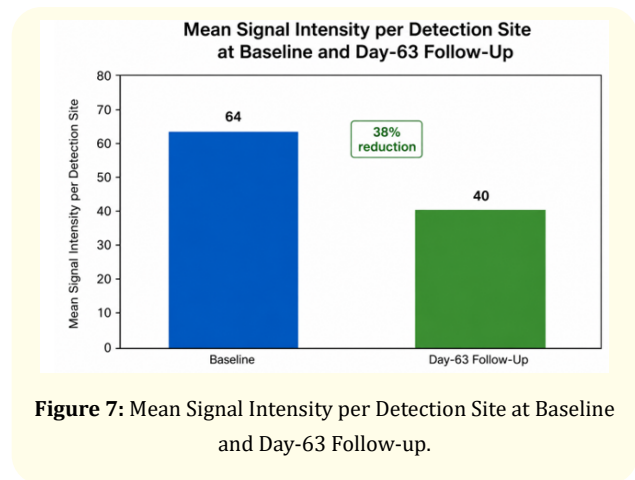


Figure 7: Mean Signal Intensity per Detection Site at Baseline and Day-63 Follow-up.

Spatial distribution of signal detections

In addition to the quantitative reductions in observed Signal Intensity Score, Active Signal Spots, and Mean Signal Intensity per Detection Site, anatomical mapping demonstrated a recurrent spatial distribution of NLJD detections across participants.

Second-harmonic-dominant responses consistent with synthetic silicon-based electronic circuitry, classified by the study protocol as Active Signal Spots, repeatedly localised within defined anatomical regions rather than being distributed without an anatomical pattern.

Individual-level variability was observed, including resolution of previously detected sites, detection of sites within recognised regions at follow-up, and minor positional variation within adjacent anatomical areas. Despite this variability, detections remained confined to a recurrent anatomical distribution across the cohort under the scanning conditions used.

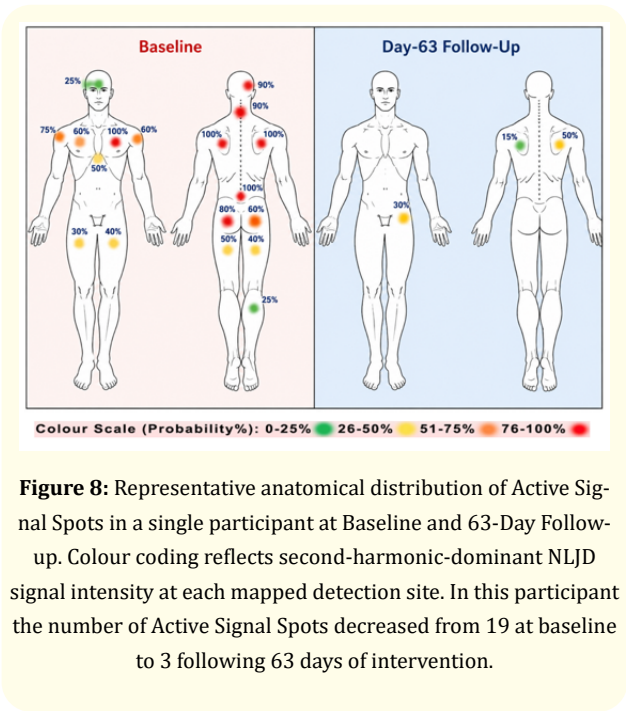
The recurrent anatomical regions identified across participants were:

- **Anterior:** Bilateral temporomandibular joint (TMJ) regions, glabella, nasal dorsum, anterior cervical region, infraclavicular region, upper pectoral region, precordial region, upper abdomen, lower abdomen, anterior thighs and medial thighs.
- **Lateral:** Bilateral shoulder regions and bilateral hip regions.

- Posterior:** Occipital region, lower cervical region, bilateral scapular regions, posterior spinal axis, gluteal region, posterior thighs and posterior calves.

Representative participant anatomical mapping

A representative example of the anatomical distribution of Active Signal Spots in a single participant at baseline and following the 63-day intervention is presented in Figure 8.



Signal Intensity at each mapped detection site is visualised using a graded colour scale: 0-25% (green), 26-50% (yellow), 51-75% (orange), and 76-100% (red). Under the study’s predefined device-detection criteria, Signal Intensity values $\geq 60\%$ were considered consistent with a positive second-harmonic-dominant return response.

This figure represents an individual participant and should not be interpreted as the pooled anatomical distribution of the full cohort. Anatomical locations corresponding to the mapped detection sites are summarised in Table 3.

Adverse events

No adverse events or participant-reported adverse effects were recorded during the study period.

Anatomical Region	Baseline	Follow-Up
Glabella	Present	Absent
Right TMJ	Present	Absent
Occipital Region	Present	Absent
Lower Cervical Region	Present	Absent
Upper Pectoral Regions	Present bilaterally	Absent
Anterior Shoulders	Present bilaterally	Absent
Upper Abdomen	Present	Absent
Scapular Region	Present bilaterally	Present bilaterally
Posterior Spinal Axis	Present	Absent
Gluteal Region	Present bilaterally	Absent
Anterior Thighs	Present bilaterally	Absent
Posterior Thighs	Present bilaterally	Absent
Posterior Calf	Present	Absent
Anterior Hip Region	Absent	Present unilaterally

Table 3: Anatomical distribution of Active Signal Spots in the representative participant shown in Figure 8 at Baseline and Day 63 follow-up. “Present bilaterally” indicates detection on both left and right sides of the body.

Discussion

Principal findings

The present exploratory cohort study identified second-harmonic-dominant nonlinear junction detector (NLJD) responses in all 22 participants at baseline, demonstrating that the phenomenon under investigation was consistently detectable within this general-population cohort. Importantly, the detected responses were not distributed randomly across the body. Anatomical mapping demonstrated recurrent localisation within defined regions, including the temporomandibular joint (TMJ), glabella, nasal dorsum, cervical, infraclavicular and pectoral regions, precordial and abdominal regions, shoulders, hips, thighs, occipital and scapular regions, spinal axis, gluteal region and posterior calves.

Following 63 days of daily supplementation with MasterPeace® Zeolite-Z®, substantial reductions were observed across all three principal NLJD-derived measures. Mean Signal Intensity Score decreased from approximately 1,340 to 277, representing a 79% reduction. Mean Active Signal Spots decreased from approximately 21 to 7 per participant, representing a 67% reduction, while Mean Signal Intensity per Detection Site decreased from approximately 64 to 40, representing a 38% reduction.

These findings are important because the reduction in cumulative Signal Intensity Score was not attributable solely to a decrease in the intensity of otherwise unchanged detection sites. Rather, two concurrent changes were observed: a substantial reduction in the number of anatomically detectable Active Signal Spots and a reduction in the mean intensity of the responses remaining detectable. Together, these changes produced the larger 79% reduction in overall Signal Intensity Score observed across the cohort.

The recurrent anatomical localisation of the second-harmonic-dominant responses is also of particular interest. Although individual variability occurred between baseline and follow-up—including resolution of previously detected sites, detection within recognised anatomical regions at follow-up and minor positional variation within adjacent areas—the responses remained localised to a recurrent anatomical distribution across the cohort under the scanning conditions employed.

This anatomical organisation is relevant when considered alongside the scientific literature concerning the development of bioelectronic technologies specifically designed to establish interfaces with biological tissues. Semiconductor nanowires have been engineered to interface with electrically active cells, including neurons and cardiac cells, while flexible silicon-based mesh electronics have been developed for integration with neural and other biological tissues. Graphene and graphene-associated conductive materials have similarly been investigated as interfaces with neuronal and other biological systems. The literature therefore demonstrates that engineered nanoscale electronic structures can be designed to establish localised electrical interfaces with specific biological tissues and cellular environments.

This spatial organisation, together with the magnitude and consistency of the reductions observed over the 63-day intervention period, provides the basis for considering the findings in relation

to the wider scientific literature concerning semiconductor nanotechnology, graphene-silicon nanoelectronic materials, biological interfaces and tissue-integrated bioelectronics.

Recent advances in bioelectronics have demonstrated that semiconductor nanowires and related nanoscale electronic materials have been engineered to interface with biological cells and tissues for sensing, recording and stimulation of cellular electrical activity. This technological literature provides an important framework within which the present NLJD findings can now be considered and forms the basis of the following discussion.

Relationship to semiconductor nanotechnology and bioelectronic interfaces

The findings of the present study can be considered within the context of the substantial body of scientific research demonstrating that semiconductor nanotechnology has been engineered to interact with biological systems. Advances in bioelectronics have demonstrated that semiconductor nanowires and related nanoscale electronic materials can be engineered to interface with biological cells and tissues for sensing, recording and stimulation of cellular electrical activity [14,15]. Patolsky, *et al.* demonstrated high-density silicon nanowire field-effect transistor arrays capable of interfacing with electrically active mammalian neurons [14], while Lieber subsequently described semiconductor nanowires as a broader technological platform for nanoelectronics, sensing and biological interfaces [15].

This technological progression is particularly relevant to the present findings because the development of semiconductor bioelectronics has moved considerably beyond conventional rigid electronic devices. Silicon nanowire field-effect transistors (SiNW-FETs) have been developed for highly sensitive biological sensing and for extracellular and intracellular electrophysiological recording. Nanowire-based bioelectronic systems have additionally been applied to electrically active cells, including neurons and cardiomyocytes, with research extending from individual cellular measurements to cell-network mapping, three-dimensional tissue recording and *in vivo* brain interfacing [14,15]. The literature therefore establishes that nanoscale semiconductor structures can be deliberately engineered to establish functional electrical interfaces with living biological systems.

The development of these technologies has also progressed from individual silicon nanowire interfaces toward three-dimen-

sional nanoelectronic networks designed for integration with biological tissue. Xie., *et al.* developed three-dimensional macroporous nanoelectronic networks as flexible brain probes, while subsequent work from Lieber and colleagues described tissue-like mesh electronics designed to overcome the structural and mechanical mismatch between conventional electronics and biological tissue. These mesh nanoelectronic systems have been incorporated into three-dimensional neural, cardiac and vascular tissue constructs and used for recording electrophysiological and chemical activity [16,17].

Of particular significance is the development of syringe-injectable mesh electronics. Liu., *et al.* demonstrated that macroporous electronic mesh structures could be delivered through a needle and subsequently unfold and interface with biological structures [18]. This research established that functional electronic systems do not necessarily require the form of conventional rigid surgically implanted devices; electronic architectures can instead be fabricated as highly flexible structures capable of minimally invasive delivery and integration with tissue [16-18].

The technological literature has developed in parallel with research into graphene and graphene-associated bioelectronic interfaces. Graphene has been investigated for neural-interface applications because of properties including electrical conductivity, mechanical flexibility, surface chemistry, wettability, porosity and mechanical characteristics relevant to interactions with neuronal cells and tissues [19]. Reviews of brain-machine-interface materials similarly describe the progression from conventional metallic and silicon electrodes toward graphene, carbon nanotubes, conductive polymers, flexible substrates and hybrid organic-inorganic materials [20].

Taken together, these studies demonstrate that semiconductor nanowires, silicon-based nanoelectronic structures, flexible and injectable mesh electronics, and graphene-associated conductive interfaces have been deliberately engineered for interaction with biological cells, tissues and organs [14-20]. This is central to the technological framework proposed by Young for the present investigation, in which graphene, oxygen and silicon are considered in relation to what he describes as GrapHene Oxidative Silicon Technology (GHOST™).

Within this framework, the second-harmonic-dominant NLJD responses detected in the present cohort are of particular interest because nonlinear junction detection is specifically designed to identify nonlinear electronic junction behaviour associated with semiconductor-containing electronic circuitry. The present study demonstrated such responses in all 22 participants at baseline, together with recurrent anatomical localisation and substantial reductions during the 63-day intervention. The established existence of nanoscale semiconductor bioelectronic technologies capable of interfacing with living tissues therefore provides an important technological context within which these findings can be considered.

Relationship to previous human analytical findings

The present NLJD findings form part of a broader programme of human research investigating environmental toxic burden, graphene oxide and other compounds of interest before and during supplementation with MasterPeace® Zeolite-Z®. Although the earlier intracellular electrical capacity (iEC) investigations employed a different analytical methodology from the NLJD measurements used in the present study, these previous findings provide an important human analytical context for consideration of the current results. The two methodologies measure different parameters and should therefore be considered complementary rather than interchangeable.

In the previously published three-participant pilot study, venous blood samples were analysed by IGL-Labor GmbH, Germany, using the iEC Cellular Toxin Examination, with intracellular measurements obtained from lymphocytes and reported in nanomoles per litre (nmol/L). Graphene oxide (2D Nano) was one of the original analytes measured at baseline, Day 35 and Day 90. Across the 90-day supplementation period, mean measured graphene oxide demonstrated a progressive reduction of approximately 72% from baseline to Day 90 [60].

The subsequent investigation expanded the analytical programme to a larger 24-participant cohort, with the iEC component incorporating an expanded 27-analyte panel. This broader panel included polypropylene (PP), polyethylene (PE), polyethylene glycol (PEG-2000), PFOS, PFOA, aluminium, titanium dioxide, graphene oxide, heavy metals and numerous additional environmental compounds. Of particular relevance to the present inves-

tigation, graphene oxide was detected within the baseline dataset, producing a cumulative concentration of 6,794.8 nmol/L across the 24 participants. Titanium dioxide and PEG-2000 were also represented within the expanded analytical panel.

These previous analytical findings are relevant to the technological framework of the present study because graphene and graphene-associated materials have been investigated within the scientific literature for their electrical conductivity and application within neural and bioelectronic interfaces, while silicon-based semiconductor nanostructures have been engineered for biological sensing, recording and stimulation. Within Young's proposed GraphHene Oxidative Silicon Technology (GHOST™) framework, the previous human iEC detection of graphene oxide provides a separate line of analytical observation that can be considered alongside the second-harmonic-dominant NLJD responses identified in the present cohort.

The observation of graphene oxide within previous human analytical datasets, together with the substantial reduction in graphene oxide observed during the published 90-day pilot study, provides relevant contextual evidence when considering the reduction in NLJD-detectable signal activity observed during the present 63-day intervention.

The present study therefore extends this research programme into a different analytical domain. Whereas the earlier investigations evaluated selected compounds through laboratory-based intracellular measurements, the current investigation quantitatively evaluated the presence, anatomical localisation, number and intensity of second-harmonic-dominant nonlinear responses. Considered together, these separate lines of investigation provide complementary human evidence relevant to the anatomical organisation observed in the present cohort.

Anatomical organisation of the NLJD responses

A notable finding of the present investigation was the recurrent anatomical organisation of the second-harmonic-dominant NLJD responses across the cohort. At baseline, qualifying responses were detected in all 22 participants; however, these Active Signal Spots were not observed as an apparently random distribution across the body. Instead, repeated detections occurred within defined anatomical regions, producing recognisable patterns across participants.

The recurrent anterior locations included the bilateral temporomandibular joint (TMJ) regions, glabella, nasal dorsum, anterior cervical region, infraclavicular and upper pectoral regions, precordial region, upper and lower abdomen, anterior thighs and medial thighs. Lateral detections included the bilateral shoulder and hip regions, while posterior detections included the occipital and lower cervical regions, bilateral scapular regions, posterior spinal axis, gluteal region, posterior thighs and posterior calves.

The importance of this observation lies not only in the presence of multiple Active Signal Spots, but in their spatial organisation and recurrence within recognised anatomical regions across different individuals. Individual variability was observed, including the disappearance of previously detected sites, minor positional variation within adjacent anatomical areas and detection of sites within recognised regions at follow-up. Nevertheless, the overall distribution remained anatomically structured under the scanning conditions employed.

This anatomical organisation is relevant when considered alongside the scientific literature concerning the development of bioelectronic technologies specifically designed to establish interfaces with biological tissues. Semiconductor nanowires have been engineered to interface with electrically active cells, including neurons and cardiac cells, while flexible silicon-based mesh electronics have been developed for integration with neural and other biological tissues [14-18]. Graphene and graphene-associated conductive materials have similarly been investigated as interfaces with neuronal and other biological systems [19,20]. The supplied literature therefore demonstrates that engineered nanoscale electronic structures can be designed to establish localised electrical interfaces with specific biological tissues and cellular environments.

The recurrent anatomical distribution observed in the present cohort is therefore of particular interest within the GraphHene Oxidative Silicon Technology (GHOST™) framework proposed by Young. Within this proposed framework, graphene-, oxygen- and silicon-associated nanoscale materials are proposed as components of a bioelectronic architecture capable of interfacing with biological tissues. The repeated localisation of second-harmonic-dominant NLJD responses within defined anatomical regions supports consideration of this relationship between the detected nonlinear responses and the wider literature concerning tissue-interfacing semiconductor and nanoelectronic technologies.

Importantly, the anatomical maps also permitted temporal changes to be evaluated at the level of individual detection sites. Following the 63-day intervention, the cohort demonstrated substantially fewer Active Signal Spots overall, while the responses that remained detectable showed a lower mean Signal Intensity. The anatomical findings therefore indicate not simply a change in total measured signal activity, but a reduction in the number of discrete anatomical locations at which qualifying second-harmonic-dominant responses could be detected.

The combination of recurrent anatomical localisation, semiconductor-type harmonic behaviour and substantial temporal reduction provides the basis for examining the nature and composition of the structures responsible for these detections. This leads to the proposed GHOST™ framework and its relationship to graphene, oxygen, silicon and nanoelectronic materials.

Proposed GraphHene oxidative silicon technology (GHOST™) framework

Young describes the proposed technological framework as GraphHene Oxidative Silicon Technology (GHOST™). Within his terminology, GraphHene incorporates graphene (G) and hydrogen (H), with hydrogen additionally associated with pH; Oxidative denotes oxygen (O) and the oxidised state of the graphene-associated component; Silicon identifies semiconductor silicon (Si); and Technology (T) describes the proposed integration of these elements within a functional technological architecture. Young therefore uses the acronym GHOST™ to encompass graphene (G), hydrogen (H), oxygen (O), silicon (Si) and technology (T) within the proposed graphene-silicon nanoelectronic framework. Within Young's proposed framework, an interconnected three-dimensional graphene-silicon nanowire or mesh configuration is described in which silicon forms the crystalline semiconductor core, graphene/carbon forms the conductive outer shell or coating, and oxygen occurs within a thin interfacial transition layer at the graphene-silicon junction.

The proposed GHOST™ framework can be considered alongside the broader scientific literature assembled for this manuscript concerning graphene- and silicon-based bioelectronics. Lieber describes semiconductor nanowires as a platform for nanoscience, nanotechnology and bioelectronics, including their application in nanoscale electronics, sensing and biological interfaces [15], while

the wider neural-interface literature describes graphene, silicon, carbon nanomaterials, conductive polymers and hybrid materials developed to improve electrical coupling, mechanical compatibility and long-term interfacing with neural tissue [19,20].

Graphene-based electrodes and transistors have been investigated specifically for recording electrical activity from neural tissue. Kuzum., *et al.* demonstrated transparent and flexible graphene electrodes for simultaneous electrophysiological recording and neuroimaging [61]; Kostarelos., *et al.* reviewed graphene-based electrodes and transistors designed for recording and stimulating neural tissue [62]; and Masvidal-Codina., *et al.* reported graphene microtransistor arrays used to record cortical activity during human epilepsy surgery [63]. More recent work has investigated carbon-nanotube/graphene arrays designed to improve mechanical and electrical stability at neural interfaces [64].

The silicon component is similarly relevant because semiconductor silicon nanowires have been engineered for electrical sensing and communication with biological cells and tissues. The published literature describes a progression from graphene-silicon nanowire biointerfaces to flexible mesh electronics and increasingly miniaturised implantable electronic systems. Young identifies four principal biotechnology classes within this literature: nanowire systems that sense cellular and neuronal electrical activity; flexible mesh electronics integrated with neural tissues; miniaturised wireless implantable systems; and graphene-based electrodes and transistors providing interfaces with biological tissue.

Within Young's proposed GHOST™ framework, microscopic and spectroscopic characterisation is used to describe a graphene-silicon interface at different structural scales. At the nanoscale, the supplied material describes a core-shell configuration comprising a crystalline silicon nanowire core surrounded by graphene-associated outer layers, with an oxygen-containing transition layer occurring at the graphene-silicon interface. At the larger scale, the proposed morphology is described as an interconnected, multi-branched three-dimensional network or mesh of silicon nanowires coated by graphene-associated outer layers.

The corresponding representative EDS/SEM analysis of this proposed graphene-silicon nanowire architecture is shown in Figure 10, illustrating the carbon-, silicon- and oxygen-associated in-

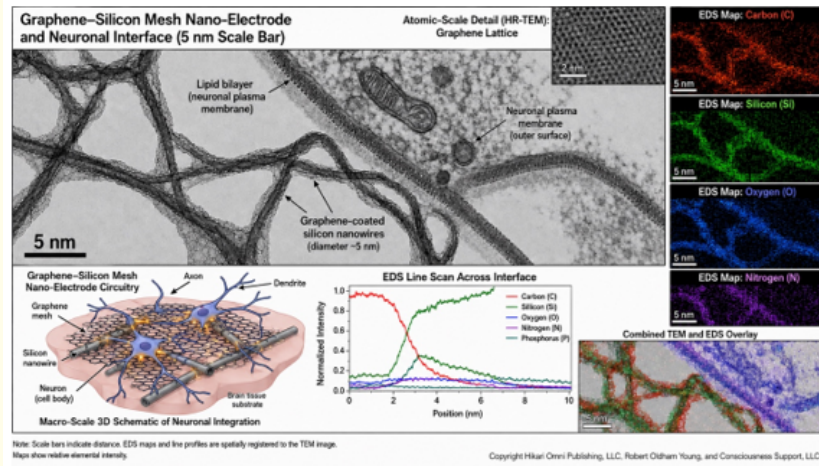


Figure 9: Representative graphene-silicon nanowire mesh and core-shell architecture. Representative SEM/TEM imagery illustrating the three-dimensional graphene-silicon nanowire mesh architecture described by Young, including a crystalline silicon nanowire core, graphene-associated outer layers and the carbon-silicon-oxygen interfacial region considered within the GHOST™ framework. This figure is representative and does not depict material obtained from participants in the present study.

terfacial characteristics described within Young's proposed framework.

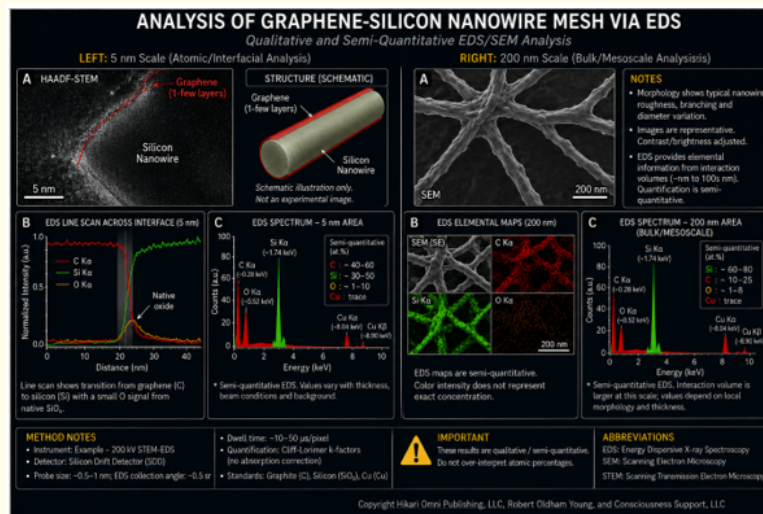


Figure 10: Representative EDS/SEM analysis of the proposed graphene-silicon nanowire mesh architecture. The figure illustrates Young's proposed graphene-associated outer layers, silicon nanowire core and carbon-silicon-oxygen interfacial region at nanoscale and mesoscale dimensions. EDS measurements are presented as qualitative/semi-quantitative representations.

This figure is representative and does not depict material obtained from participants in the present study.

This proposed configuration provides the structural basis for Young's GHOST™ terminology, bringing together the conductive characteristics of graphene, the semiconductor properties of silicon and the graphene-silicon-oxygen interfacial morphology described within the framework, and placing these components within the wider development of nanoscale bioelectronic and neural-interface technologies.

As described earlier and illustrated in Figure 1, Young's previous electron microscopy and EDS/EDX investigations reported graphene- and silicon-associated signatures within the materials examined [24]. These earlier analytical observations form part of the basis upon which Young subsequently proposed the GrapHene Oxidative Silicon Technology (GHOST™) framework considered in the present investigation.

The relevance of this proposed framework to the present study arises from the characteristics of the NLJD responses themselves.

The EDD-24XT identified second-harmonic-dominant responses classified operationally by the instrument as "Probability Silicon," and these responses were detected at multiple anatomically localised sites across all participants at baseline. The study therefore provides a measured nonlinear harmonic phenomenon that can be considered in relation to Young's proposed GHOST™ framework.

Within the wider technological interpretation proposed by Young, GHOST™ is further considered in relation to Wireless Body Area Network (WBAN) technology. Published research concerning graphene- and silicon-based neural interfaces, flexible mesh electronics and miniaturised wireless implantable systems provides the technological background for considering whether nanoscale bioelectronic structures may communicate with external systems. This proposed relationship between GHOST™, wireless communication and WBAN technology is considered in the following section.

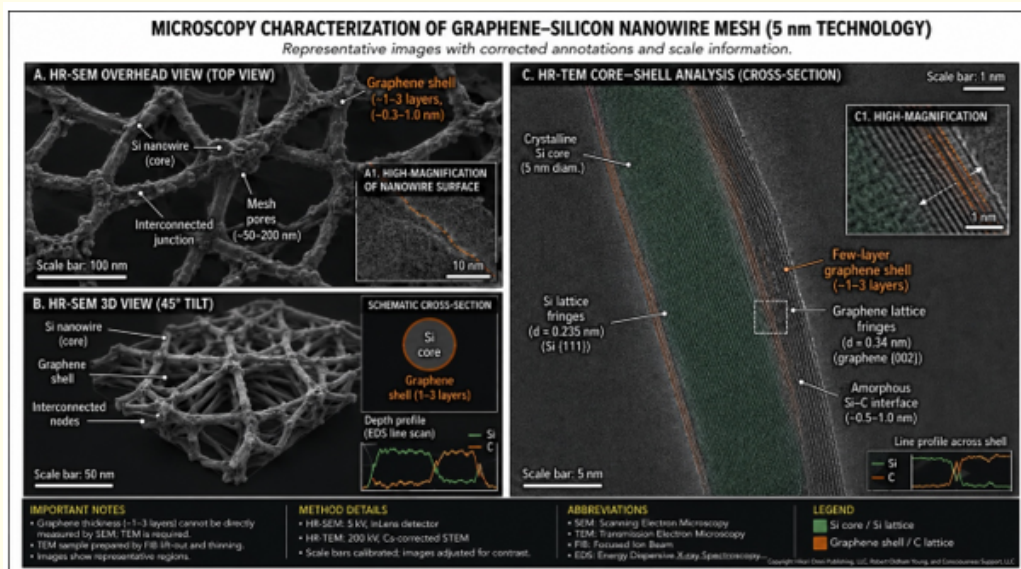


Figure 11: Representative graphene-silicon nano-electrode and neural-interface architecture. Representative microscopy/EDS-associated imagery and schematic representation illustrating a graphene-silicon nano-electrode configuration in relation to neural bioelectronic interfacing and Young's proposed GHOST™/WBAN information pathway. This figure is representative and does not depict material obtained from participants in the present study.

GHOST™, wireless body area networks and bioelectronic communication

The proposed GrapHene Oxidative Silicon Technology (GHOST™) framework can be further considered within the established field of Wireless Body Area Networks (WBANs). WBAN technology enables short-range communication between sensors, actuators and electronic devices positioned on, within or in the immediate vicinity of the human body. The IEEE 802.15.6 standard specifically defines wireless communication in the vicinity of, or inside, the human body, incorporating requirements for low-power operation, quality of service and reliable data transmission [47]. Takizawa, *et al.* further characterised radio-propagation channels for WBAN applications using wearable sensors positioned in relation to the human body, providing an experimental engineering basis for communication between body-associated electronic devices [23].

Within biomedical engineering, WBANs may incorporate wearable or implanted sensors capable of acquiring physiological information and communicating that information through a coordinating device or gateway to external systems. Published WBAN architectures describe physiological data being collected by body-associated nodes, transmitted to a personal server or gateway and subsequently transmitted through the Internet to remote servers capable of processing, analysing and storing that information [48,49]. This establishes an information pathway extending from the human body through wireless communication to external computing, cloud/server and data-centre infrastructure.

This communication framework is particularly relevant when considered alongside the parallel development of miniaturised bioelectronic devices. Semiconductor nanowires, flexible and injectable mesh electronics and graphene-associated interfaces provide experimentally demonstrated technologies capable of establishing intimate electrical contact with biological systems, while WBAN and miniaturised wireless bioelectronic technologies provide mechanisms through which information originating at body-associated electronic interfaces can be transmitted beyond the original sensing location.

An important example is the development of “neural dust”, in which miniaturised implanted sensor nodes have been experimentally developed to interface with peripheral nerves and communicate through ultrasound. Proof-of-concept work demonstrated an implanted mote capable of recording activity from the sciatic nerve

of an anaesthetised rat, using externally delivered ultrasound for power and communication. Related research has continued toward distributed networks of miniaturised neural implants capable of recording and stimulating neural activity, extending the concept of individually implanted electronic interfaces toward networked bioelectronic systems.

DARPA's Next-Generation Nonsurgical Neurotechnology (N³) programme provides further technological context for the development of bidirectional interfaces between neural activity and external electronic systems. The programme funded multiple approaches employing optical, acoustic and electromagnetic technologies for recording from and writing to the brain, including minutely invasive systems incorporating nanoscale transducers coupled to external transceivers. DARPA identified potential applications including human-machine interaction, control of unmanned systems and interaction with computer-based systems [65,66].

Taken together with the graphene and semiconductor literature described previously, these developments demonstrate the technological feasibility of combining biological sensing, nanoscale or microscale electronics, signal processing and external communication. In the technological pathway described by Young, biological electrical activity interfaces with a bioelectrode or biotransistor, followed by amplification and digitisation, communication through an engineered link, and subsequent external signal processing.

Young proposes that GHOST™ may represent a graphene-silicon-based bioelectronic architecture associated with such a Wireless Body Area Network (WBAN), in which anatomically localised graphene- and silicon-associated structures interface with biological electrical activity and potentially communicate through external wireless systems. Within this proposed framework, the information pathway may extend beyond the local external computer through wider communications networks to remote servers and data-centre infrastructure, where biologically derived digital information may be processed, analysed and stored [48,49]. Young therefore considers WBAN communication, external computing and data centres as interconnected components within a wider technological information and data-transmission pathway connecting biological sensing with external computational systems.

The present findings are particularly relevant to this proposed framework because qualifying second-harmonic-dominant re-

sponses were identified in all 22 participants at baseline and occurred repeatedly within defined anatomical regions. Following the 63-day intervention, the number and cumulative intensity of these responses were substantially reduced. These observations demonstrate measurable changes in anatomically localised non-linear harmonic activity and provide a basis for further investigation of the proposed relationship between the detected responses, GHOST™ and body-associated bioelectronic communication.

The wider biological significance of such a proposed graphene-silicon bioelectronic interface must also be considered. Published research has examined the interaction of graphene oxide, graphene-associated materials, silicon nanowires and radiofrequency electromagnetic exposure with biological cells and tissues, including effects involving oxidative stress, mitochondrial function, inflammatory responses, apoptosis and genotoxicity. These findings provide the basis for considering the potential biological implications of the phenomenon investigated in the present study.

Biological implications

The potential biological significance of the present findings may be considered in relation to the published literature concerning the interaction of graphene oxide, graphene-associated materials, silicon nanowires and electromagnetic fields with biological systems. These areas are particularly relevant within Young's proposed GHOST™ framework because graphene-associated conductive materials and silicon-based semiconductor structures are central components of the proposed technology, while WBAN communication introduces an additional electromagnetic component.

Biological effects of graphene oxide

The increasing development of graphene-based materials for biomedical and bioelectronic applications has been accompanied by substantial investigation of their potential biological effects. Experimental studies demonstrate that the biological response to graphene oxide (GO) can vary according to its physicochemical characteristics, oxidation state, concentration, exposure conditions and the biological environment in which it is encountered [29-31].

Lu, *et al.* investigated the mechanisms underlying the cytotoxicity of graphene oxide derivatives in mammalian cells and demonstrated that biological responses were influenced by the physicochemical characteristics of the GO material and conditions of

exposure [29]. Zhang, *et al.* similarly examined GO preparations with differing oxidation states and demonstrated oxidation-state- and concentration-dependent cytotoxicity in mammalian cells [30]. Transmission electron microscopy additionally demonstrated internalisation of the GO samples by mammalian cells [30]. These findings support consideration of GO as a material whose biological effects may vary according to its physicochemical state and exposure conditions rather than as a biologically uniform substance [29,30].

Oxidative stress and mitochondrial dysfunction represent particularly important mechanisms investigated within this literature. Feng, *et al.* reported a relationship between GO exposure, reactive oxygen species (ROS), mitochondrial dysfunction and mitochondrial-dependent apoptosis through a ROS-p53-mPTP-associated pathway in intestinal cells [32]. These findings provide mechanistic evidence linking GO exposure, under the experimental conditions studied, with oxidative stress, altered mitochondrial function and programmed cell death [32].

Potential genotoxic and pulmonary effects have also been investigated. El-Yamany, *et al.* examined graphene oxide nanosheet exposure in mice, assessing chromosomal aberrations, DNA fragmentation, oxidative-stress markers and pulmonary histopathology [33]. The investigators reported genotoxic effects and pulmonary injury under the experimental exposure conditions [33].

The biological environment may further influence these responses. Li, *et al.* investigated GO nanosheet toxicity in mice and reported that protein-corona composition and host immune status influenced the biological response, including the severity of acute lung injury [31].

Additional experimental research has investigated the potential reproductive effects of nanoscale GO. Liang, *et al.* reported very low or nearly no reproductive toxicity in male mice under the experimental conditions investigated [67]. In contrast, Li, *et al.* using human ovarian granulosa cells, reported dose-dependent cell death and mitochondrial alterations following GO exposure, including decreased ATP production and mitochondrial membrane potential [68]. These differing findings further demonstrate that the biological effects of GO may vary according to the experimental model, exposure conditions and biological environment [67,68].

Collectively, these studies demonstrate that graphene oxide can interact with mammalian cells and tissues and, under defined experimental conditions, has been associated with cytotoxicity, oxidative stress, mitochondrial dysfunction, apoptosis, genotoxicity, pulmonary injury and reproductive cellular effects [29-33,67,68]. Importantly, the nature and magnitude of these biological effects vary according to factors including physicochemical properties, oxidation state, concentration, exposure duration, route of administration and the surrounding biological environment [29-31,67,68].

Biological interaction and effects of silicon nanowires

Silicon nanowires occupy a particularly relevant position within the present discussion because the same broad class of semiconductor structures developed for biosensing and bioelectronic interfaces has also been investigated for cellular interaction, internalisation, distribution, clearance, biocompatibility and potential toxicity [26-28,34,35].

Roberts, *et al.* investigated the pulmonary toxicity, distribution and clearance of intratracheally administered silicon nanowires in rats [26]. The researchers reported dose-dependent pulmonary injury and inflammation following silicon-nanowire exposure, together with macrophage uptake and clearance [26]. Increased lung collagen and persistence of material at later observation periods were reported in the higher-exposure groups [26].

Song, *et al.* examined silicon-nanowire cytotoxicity across four mammalian cell lines and found that biological responses varied according to cell type, concentration and duration of exposure [27]. The investigators also observed close interaction between silicon nanowires and cellular membranes, with effects upon cellular adhesion and viability under particular experimental conditions [27].

Cellular internalisation of silicon nanowires has additionally been demonstrated experimentally. Condò, *et al.* investigated cytotoxicity and internalisation of functionalised silicon nanowires in Buffalo Green Monkey cells and confirmed cellular internalisation using confocal fluorescence microscopy [28]. The broader biocompatibility literature reviewed by Marcon and Boukherroub further considers both *in vitro* and *in vivo* evidence concerning semiconductor silicon nanowires, their interaction with biological systems and their potential biological effects [34].

Collectively, these studies demonstrate the dual biological relevance of silicon nanowires. Their semiconductor and nanoscale structural properties permit intimate interaction with cells and tissues and make them useful platforms for biomedical sensing and bioelectronic interfaces [28,34]. However, these same properties also necessitate consideration of cellular internalisation, distribution, persistence, clearance and potential biological effects [26-28,34].

Radiofrequency exposure and biological effects

The proposed association between GHOST™ and WBAN communication additionally raises the question of biological responses to radiofrequency and electromagnetic-field exposure. The wider literature assembled for this manuscript includes experimental studies reporting biological changes under defined RF/EMF exposure conditions across oxidative, neurological, developmental and reproductive endpoints [36-40].

Young's live- and dried-blood investigations involving electromagnetic-field challenge were reported by Rubik and Jabs in 2001 [41]. The investigation examined blood samples obtained before and after participants wore active or inactive devices, with differences in blood morphology interpreted in relation to the biological effects of electromagnetic exposure. Rubik subsequently incorporated Young's observations within her broader 2002 review of Sympathetic Resonance Technology and biological responses to chemical and electromagnetic stress [9]. Together, these publications provide historical context for Young's continuing investigation of potential biological responses associated with electromagnetic-field exposure [9,41].

Çelik, *et al.* investigated 2.45-GHz Wi-Fi exposure during pregnancy and early development in rats and reported increased oxidative stress in brain and liver tissues, including increased lipid peroxidation and reductions in several antioxidant defence measures [36]. Güler, *et al.* investigated intrauterine and extrauterine exposure at 1800-MHz radiofrequency radiation and reported neurodegenerative changes, oxidative DNA damage and histopathological alterations in brain tissue under defined experimental conditions [37]. Odacı, *et al.* reported reduced Purkinje cell numbers and pathological neuronal changes in the cerebellum of female rat offspring following maternal exposure to a continuous 900-MHz electromagnetic field [38]. Additional experimental research has

examined reproductive, prenatal and postnatal developmental outcomes associated with electromagnetic-field exposure [39].

At the mechanistic level, Yakymenko, *et al.* reviewed experimental evidence concerning the oxidative effects of low-intensity radiofrequency radiation, including ROS generation, lipid peroxidation, oxidative DNA damage and changes in antioxidant-enzyme activity [40]. The authors proposed oxidative stress as an important mechanism through which low-intensity radiofrequency exposure may produce biological effects [40].

Considered together, the graphene oxide, silicon nanowire and RF/EMF literature provides a biological context for Young's proposed GHOST™ framework. Graphene oxide has been associated experimentally, under defined exposure conditions, with oxidative stress, mitochondrial dysfunction, apoptosis, genotoxicity and other biological effects [29-33,67,68]. Silicon nanowires have demonstrated cellular interaction and internalisation, together with exposure-dependent biological effects, distribution and clearance [26-28,34]. Radiofrequency and electromagnetic-field exposure has additionally been investigated in relation to oxidative, neurological, developmental and reproductive biological responses [36-40].

Oxidative stress represents a point of convergence within several of these areas of research [29,30,32,36,40,68]. Young has additionally considered oxidative stress in relation to altered blood rheology, fibrin-associated coagulation and endothelial processes. In Pathological Blood Coagulation and the Mycotoxic Oxidative Stress Test (MOST), Young discussed pathological intravascular coagulation in relation to abnormal fibrin/fibrinogen polymerisation, oxidative stress and changes within the blood and vascular environment [69]. This work provides additional context for considering potential physiological consequences associated with oxidative stress and altered biological environments within the broader framework of the present investigation.

These converging areas of research provide a biological basis for considering why the substantial reduction in anatomically localised nonlinear harmonic responses observed following the 63-day intervention warrants further investigation.

Proposed mechanism of intervention and reduction in NLJD responses

The final component of the present Discussion concerns the intervention itself and the proposed mechanisms by which supplementation with MasterPeace® Zeolite-Z® may be associated with the substantial reductions in NLJD-detected signal activity observed during the 63-day study period.

The principal mineral component of MasterPeace® Zeolite-Z® is natural clinoptilolite, whose crystalline aluminosilicate framework and associated negative structural charge give rise to established cation-exchange, adsorption and molecular-sieving properties [56-59]. As described earlier, these physicochemical characteristics provided the material-science rationale for the selection of natural clinoptilolite as the principal mineral component of the intervention [56-59].

An important distinction within the proposed mechanism is that the silicon naturally occurring within clinoptilolite is chemically and structurally distinct from the semiconductor silicon considered within the GHOST™ framework. In clinoptilolite, silicon is framework-bound within a naturally occurring crystalline aluminosilicate structure containing silicon, aluminium and oxygen [56-59]. It is therefore distinct from elemental semiconductor silicon, engineered silicon nanowires and silicon-based electronic circuitry discussed elsewhere in this manuscript [14-16]. The intervention should consequently not be interpreted as introducing the same form of silicon that it is proposed to assist in removing.

These physicochemical characteristics provide the material-science basis for Young's proposed use of clinoptilolite as a binding, adsorption and ion-exchange intervention within the present research programme [57-59]. The proposed mechanism is that the negatively charged aluminosilicate framework and associated surface and channel characteristics of clinoptilolite permit interaction with selected positively charged or adsorbable substances, facilitating their sequestration and subsequent elimination. The effectiveness of such interactions is dependent upon the physicochemical characteristics of both the clinoptilolite and the material encountered [57-59].

Previous human investigations within this research programme provide additional context for this proposed mechanism. In the

published three-participant pilot study, intracellular electrical capacity (iEC) measurements demonstrated progressive reductions across the 90-day supplementation period in multiple measured compounds, including graphene oxide, with mean measured graphene oxide decreasing by approximately 72% from baseline to Day 90 [60]. The intervention in that study similarly incorporated MasterPeace® Zeolite-Z®, providing a preceding longitudinal human observation of measurable change in compounds of interest during supplementation.

The present study extends these observations into a separate measurement domain. Rather than measuring intracellular concentrations of selected analytes, the current investigation quantified anatomically localised second-harmonic-dominant nonlinear responses using NLJD instrumentation. Following 63 days of MasterPeace® Zeolite-Z® supplementation, mean Signal Intensity Score decreased from approximately 1,340 to 277 (–79%), mean Active Signal Spots decreased from approximately 21 to 7 (–67%), and Mean Signal Intensity per Detection Site decreased from approximately 64 to 40 (–38%).

The magnitude of the reduction in Active Signal Spots is particularly relevant to the proposed intervention mechanism. The observed change was not limited to attenuation of signal intensity at otherwise unchanged anatomical locations; rather, numerous previously detectable sites no longer produced qualifying second-harmonic-dominant responses at follow-up. The simultaneous reduction in both the number of detectable anatomical sites and the intensity of remaining responses resulted in the larger 79% reduction in overall Signal Intensity Score.

Within Young's proposed GHOST™ framework, these findings are interpreted as being consistent with a reduction in the presence or detectable nonlinear activity of graphene-silicon-associated nanoelectronic structures during the intervention period. The previous iEC findings demonstrating reductions in graphene oxide and other measured compounds following MasterPeace® supplementation provide a separate line of human analytical evidence supporting the proposed removal model [60], while the established adsorption and ion-exchange properties of clinoptilolite provide a physicochemical framework through which the intervention may be considered [57–59].

Taken together, the present findings demonstrate a substantial temporal association between daily MasterPeace® Zeolite-Z® supplementation and reductions in NLJD-detected nonlinear harmonic activity. When considered alongside the established physicochemical properties of clinoptilolite and the previous human analytical findings, these observations provide the basis for Young's proposed mechanism in which clinoptilolite contributes to the sequestration and removal of materials associated with the GHOST™ framework, resulting in a measurable reduction in anatomically localised nonlinear harmonic responses.

The present investigation therefore completes a progression from the detection and anatomical mapping of the phenomenon, through consideration of semiconductor and bioelectronic technology, graphene-silicon materials, GHOST™ and WBAN communication, to the observation that the measured phenomenon was substantially reduced during a defined 63-day clinoptilolite intervention.

Study limitations

The present study was designed as an exploratory pre-post cohort investigation and therefore has several limitations that should be considered when interpreting the findings. Although substantial and consistent temporal reductions in NLJD-derived signal parameters were observed across the cohort, the study did not include a placebo comparator; sham scanning condition, blinded allocation or independent replication arm. The sample size was also modest, comprising 22 participants. These factors limit causal inference and the broader generalisability of the findings.

The NLJD technology employed in this investigation measures nonlinear harmonic return responses and provides instrument classifications when the detected signal characteristics are consistent with semiconductor-type junction behaviour. NLJD does not directly determine the elemental, chemical or structural composition of the material responsible for an individual detection. Accordingly, the second-harmonic-dominant responses described throughout this study represent measured harmonic behaviour consistent with semiconductor-type nonlinear junctions rather than direct chemical identification of graphene, silicon nanowires or GHOST™ material.

No tissue samples were collected from the anatomical Active Signal Spots identified during the present investigation, and con-

temporaneous SEM, TEM, EDS, Raman spectroscopy or other direct material-characterisation methods were not performed at these sites. Consequently, although previously published microscopy, spectroscopy and material-characterisation studies provide technological and analytical context for the proposed interpretation, the physical composition of the structures or materials responsible for the NLJD responses in these 22 participants remains to be directly established. This distinction is particularly important when considering the proposed GraphHene Oxidative Silicon Technology (GHOST™) framework.

Similarly, the intracellular electrical capacity (iEC) findings discussed within this manuscript were obtained from separate previous human investigations and separate participant cohorts. The published three-participant pilot provided longitudinal intracellular measurements of graphene oxide and other selected analytes, while the iEC component of the subsequent 24-participant investigation provided a broader baseline profile across 27 measured analytes. The present 22-participant NLJD cohort did not undergo iEC analysis; therefore, the previous iEC findings provide supporting analytical context but cannot establish the composition of the NLJD-detected responses observed in the present participants.

The study also did not directly measure the proposed adsorption, ion-exchange, sequestration or elimination mechanism during the 63-day intervention. Clinoptilolite possesses established physicochemical properties relevant to adsorption and ion exchange, and previous human investigations provide separate evidence of temporal changes in selected measured compounds during MasterPeace® Zeolite-Z® supplementation; however, the present study measured changes in NLJD-derived signal parameters rather than direct movement or excretion of a chemically identified material.

Likewise, the proposed relationship between the detected responses, GHOST™, Wireless Body Area Network (WBAN) technology and external wireless communication represents a proposed interpretative framework arising from the present observations considered alongside the wider semiconductor, bioelectronic and wireless-communication literature. The present study did not directly measure data transmission, network connectivity or communication between the detected anatomical sites and external devices, computing systems or data-centre infrastructure.

Despite these limitations, several features strengthen the observational findings. All 22 participants completed baseline and Day 63 assessments, the same NLJD instrument and standardised scanning methodology were used, and substantial reductions were observed across all three principal signal parameters. Signal Intensity Score decreased by approximately 79%, Active Signal Spots by approximately 67%, and Mean Signal Intensity per Detection Site by approximately 38%. The consistency, magnitude and anatomical organisation of these temporal changes provide a basis for further controlled and independently replicated investigation.

Future research and implications

The findings of the present investigation identify several priorities for future research. Foremost is the need for independent replication of the NLJD phenomenon itself. The recurrent second-harmonic-dominant responses observed across all 22 participants, their anatomical organisation and their substantial temporal reduction warrant investigation in larger cohorts using the same standardised scanning methodology. Future studies should incorporate placebo or comparator groups, sham scanning procedures, blinded assessment and independent operators to establish the reproducibility and specificity of the observed signal behaviour.

A particularly important next step would be to combine NLJD anatomical mapping with direct material characterisation. Where ethically and technically feasible, biological samples obtained from, or analytically corresponding to, recurrent Active Signal Spot locations could be examined using complementary analytical techniques such as scanning electron microscopy (SEM), transmission electron microscopy (TEM), energy-dispersive X-ray spectroscopy (EDS), Raman spectroscopy and other appropriate compositional and structural methods. This would enable future investigations to determine whether anatomically localised second-harmonic-dominant responses correspond with identifiable semiconductor, graphene-associated, silicon-associated or other materials rather than relying upon harmonic behaviour alone.

Future investigations could additionally combine NLJD assessment with longitudinal laboratory analysis of biological samples from the same participants. The earlier iEC investigations and the present NLJD study currently represent separate cohorts and different analytical methodologies.

A future protocol incorporating baseline and follow-up material analysis alongside contemporaneous NLJD scanning would permit direct evaluation of whether changes in chemically identified compounds correspond temporally and quantitatively with changes in the number, anatomical distribution and intensity of NLJD-detectable responses.

The recurrent anatomical distribution observed in the present study also warrants more detailed investigation. Future studies should evaluate whether the same anatomical focal regions are reproduced across larger and geographically independent populations and whether individual locations demonstrate stable, transient or recurrent patterns over time. Higher-resolution anatomical mapping and repeated intermediate assessments could help establish the temporal behaviour of individual Active Signal Spots and determine whether changes occur progressively during intervention or within particular periods of exposure.

The proposed GrapHene Oxidative Silicon Technology (GHOST™) framework also generates testable questions for future investigation. Direct compositional analysis would be required to determine whether graphene-, oxygen- and silicon-associated materials are present at locations corresponding to NLJD detections and, if identified, to characterise their morphology, dimensions and structural relationships. Such work could then be compared directly with the established literature concerning semiconductor nanowires, graphene-based biointerfaces, mesh nanoelectronics and other tissue-interfacing electronic technologies.

Similarly, the proposed relationship between GHOST™ and Wireless Body Area Network (WBAN) communication requires direct experimental investigation. Future research could combine NLJD mapping with appropriately controlled radiofrequency-spectrum analysis and other electromagnetic measurement techniques to determine whether detectable communication or transmission occurs from identified anatomical locations. Where signal transmission is demonstrated, subsequent investigation could examine signal characteristics, frequency, directionality, modulation and interaction with external communication or computing systems.

The intervention itself also warrants further mechanistic investigation. Clinoptilolite possesses established adsorption, ion-exchange and molecular-sieving properties associated with its naturally occurring aluminosilicate structure. Future studies should examine whether changes in NLJD signal parameters correlate

with changes in analytically identified materials and their elimination over time. Dose-response studies, intermediate sampling points and controlled comparisons could additionally help determine the temporal relationship between MasterPeace® Zeolite-Z® administration and changes in measured signal activity.

Finally, the biological implications of the observed phenomenon require investigation independently of its proposed technological interpretation. Studies incorporating markers of oxidative stress, mitochondrial function, inflammation, coagulation, neurological function and other relevant physiological parameters could determine whether the presence, intensity or reduction of anatomically localised nonlinear harmonic responses corresponds with measurable biological changes. Such multidisciplinary investigation would integrate material science, analytical chemistry, bioelectronics, electromagnetic measurement and human physiology.

The present study therefore provides a foundation for a broader programme of investigation directed not only toward replication of the observed NLJD phenomenon, but toward determining its material composition, biological significance, technological characteristics and responsiveness to intervention. Independent replication combined with direct material characterisation will be particularly important in establishing the nature and wider significance of these findings.

Conclusion

The present 63-day exploratory human cohort study identified second-harmonic-dominant nonlinear junction responses classified by the EDD-24XT as “Probability Silicon” in all 22 participants at baseline, with detections occurring repeatedly within defined anatomical regions rather than as an apparently random distribution. Following daily supplementation with MasterPeace® Zeolite-Z®, substantial reductions were observed across all principal NLJD-derived measures. Mean Signal Intensity Score decreased from approximately 1,340 to 277 (–79%), mean Active Signal Spots decreased from approximately 21 to 7 per participant (–67%), and Mean Signal Intensity per Detection Site decreased from approximately 64 to 40 (–38%).

These findings demonstrate that the overall reduction reflected both a substantial decrease in the number of anatomically detectable Active Signal Spots and a reduction in the average intensity of those responses that remained detectable. The magnitude and

consistency of these changes extend previous human investigations within this research programme—including the published three-participant pilot in which longitudinal laboratory analysis demonstrated reductions in graphene oxide and other measured compounds during MasterPeace® Zeolite-Z® supplementation—into a separate analytical domain based upon nonlinear harmonic detection.

Considered within the technological literature assembled for this investigation, the findings are consistent with key elements of Young's proposed GraphHene Oxidative Silicon Technology (GHOST™) framework. Semiconductor silicon nanowires, graphene-associated conductive interfaces, flexible mesh nanoelectronics and miniaturised bioelectronic systems have been engineered to interface with biological cells and tissues for sensing, recording and stimulation of electrical activity. Within Young's proposed framework, the recurrent anatomically localised second-harmonic-dominant responses observed in the present study are considered in relation to graphene-silicon-based bioelectronic architecture and the wider development of Wireless Body Area Network technology.

The substantial reduction in these responses during the intervention period provides the basis for further investigation of Young's proposed role of MasterPeace® Zeolite-Z® as an intervention within this framework. Natural clinoptilolite possesses established adsorption, ion-exchange and molecular-sieving properties arising from its crystalline aluminosilicate structure. When considered alongside the previous human analytical findings and the present reduction in NLJD signal activity, these properties provide a physicochemical basis for further investigation of clinoptilolite in relation to the sequestration and removal of materials associated with the proposed GHOST™ framework.

Importantly, the silicon naturally occurring within clinoptilolite should not be confused with the semiconductor silicon considered within the proposed GHOST™ framework. In clinoptilolite, silicon is framework-bound within a naturally occurring crystalline aluminosilicate structure containing silicon, aluminium and oxygen. This material is chemically and structurally distinct from elemental semiconductor silicon, engineered silicon nanowires and silicon-based electronic circuitry. The presence of silicon within clinoptilolite therefore does not indicate that the intervention contains or introduces the same form of silicon that it is proposed to assist in removing.

The 79% reduction in cumulative Signal Intensity Score, 67% reduction in Active Signal Spots and 38% reduction in Mean Signal Intensity per Detection Site represent substantial and measurable longitudinal changes. When considered alongside the recurrent anatomical distribution of the baseline responses, their classification by the EDD-24XT as 'Probability Silicon,' and the technological literature discussed throughout this paper, these findings further support investigation of their relationship to the proposed GHOST™ framework.

Taken together, the findings provide a foundation for continued multidisciplinary investigation into the nature, composition, biological significance and potential responsiveness to intervention of anatomically localised semiconductor-type nonlinear responses within the human body. Future studies combining NLJD mapping with direct chemical and structural analysis, biological measurements and controlled intervention designs will enable further characterisation of these anatomically localised nonlinear responses, their relationship to the proposed GHOST™ framework, and their responsiveness to clinoptilolite-based interventions.

Conflict of Interest

This study evaluated the effects of the commercially available product MasterPeace®. Product supply and study support were provided by parties associated with the product's development and distribution. These associations are disclosed for transparency, and the findings are presented based on the observational data collected during the investigation.

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