International Journal of Science Academic Research
Vol. 06, Issue 09, pp.10647-10651, September 2025
Available online at http://www.scienceijsar.com

ISSN: 2582-6425

Research Article

MATERIALS AND GEOMETRICAL DESIGNS FOR FUTURE SKIN-ATTACHABLE WEARABLE HEALTH-CARE SYSTEM

***Seungjun Roh**

Korea International School Jeju, South Korea

Received 10th July 2025; **Accepted** 12th August 2025; **Published online** 30th September 2025

Abstract

Recent advances in materials science, biomedical engineering, and device design have driven the development of next-generation skin-attachable wearable healthcare systems capable of continuous, real-time, and non-invasive monitoring of diverse physiological parameters. This review summarizes recent progress in advanced materials, such as soft elastomers, intrinsically stretchable conductors, hydrogels, and nanocomposites, which enable intimate skin integration and stable operation under deformation. Structural design innovations, including serpentine interconnects, island-bridge configuration, are discussed as well in relation to mechanical durability and wearer comfort. Additionally, advances in integrated physiological sensors ranging from ECG, PPG, and EEG to SpO_2, blood pressure, glucose, and temperature monitors are examined for their role in enabling comprehensive, multi-modal health monitoring within a single wearable platform. These sensors transduce diverse bio-signals into measurable electrical data with clinically relevant accuracy, while IoT-based wireless communication and AI-assisted analytics enhance remote diagnostics, personalized baseline tracking, and real-time anomaly detection. Key challenges and future research directions are outlined to guide the clinical translation of these technologies into robust, decentralized healthcare solutions capable of operating reliably in real-world environments.

Keywords: Materials, Health-care.

INTRODUCTION

Recent advances in wearable bioelectronics have accelerated the development of skin-attachable healthcare systems capable of real-time, continuous, and non-invasive monitoring of diverse physiological parameters. These systems, which conform seamlessly to the human skin, are poised to revolutionize personalized medicine, early disease diagnosis, and decentralized healthcare services. However, to fully realize their clinical potential, such systems must be designed to address both practical medical needs and the complex biomechanical properties of the human body. This has led to interdisciplinary efforts in materials science, biomedical engineering, and device design. One of the primary motivations behind these systems is the growing clinical need for portable, real-time measurement platforms that allow continuous health monitoring outside of clinical settings. Traditional hospital-based diagnostics are often limited by time, location, and patient accessibility, making it difficult to capture transient or chronic physiological abnormalities. Wearable healthcare devices provide a promising alternative by enabling long-term, at-home monitoring of vital signs such as heart rate, muscle activity, skin temperature, hydration level, and biochemical markers in sweat. These capabilities are especially critical in managing chronic diseases, monitoring recovery from surgery or injury, and supporting aging populations. To support these applications, advanced materials for wearable healthcare systems have been at the forefront of research. Recent developments include soft, skin-like substrates (e.g., PDMS, Ecoflex), intrinsically stretchable conductors (e.g., PEDOT:PSS, CNTs, Ag nanowires), hydrogels with ionic conductivity, and biodegradable or breathable films. These materials exhibit mechanical properties closely matched to skin while maintaining stable electrical performance during deformation. Moreover, the incorporation of nanocomposites and self-healing polymers has improved device durability, signal fidelity, and biocompatibility essential features for long-term skin-interfaced operation. In parallel, structural and system-level design strategies have been progressively advanced to satisfy the multifunctional performance demands and ensure ergonomic compatibility with dynamic skin surfaces. Structural innovations such as serpentine interconnects, island-bridge configurations, and kirigami-inspired geometries have been employed to enhance mechanical stretch ability and strain isolation. Additionally, multilayer device designs combining breathable adhesives, encapsulants, and soft interfaces help maintain strong skin adhesion without irritation. System-level integration of flexible batteries, wireless communication (e.g., NFC, BLE), and low-power circuitry also supports untethered, continuous operation for practical deployment. At the heart of these platforms are the physiological sensors that capture and interpret bio-signals. These include electrophysiological sensors (e.g., ECG, EMG, EEG), temperature and pressure sensors, and chemical sensors for detecting sweat biomarkers like glucose, lactate, or electrolytes. The miniaturization and multiplexing of such sensors enable multi-modal health monitoring from a single device. Recent efforts also emphasize data processing and AI-assisted analytics to interpret signals in real-time, improving diagnostic accuracy and clinical utility. In this review, we provide a comprehensive overview of the materials and design strategies that underpin next-generation skin-attachable wearable healthcare systems. The discussion is structured around four key aspects: (1) clinical needs driving real-time portable monitoring platforms, (2) material innovations enabling flexible and biocompatible interfaces, (3) device design strategies for robust performance and comfort, and (4) physiological sensors and signal acquisition methods. By

Corresponding Author:** ***Seungjun Roh,
Korea International School Jeju, South Korea.

integrating insights from recent studies, we highlight the current challenges, representative applications, and future directions needed to transition these technologies from laboratory prototypes to clinically and commercially viable healthcare solutions.

Clinical needs for portable real-time measurement system

The clinical demand for portable real-time measurement systems has rapidly grown in response to the global shift toward personalized, preventive, and decentralized healthcare. Traditional diagnostic practices, which rely on bulky, hospital-based equipment and intermittent measurements, are increasingly insufficient for managing the rising prevalence of chronic diseases, the needs of aging populations, and the demand for cost-effective care. In contrast, skin-attachable wearable healthcare systems offer a transformative solution by enabling continuous, real-time, and non-invasive monitoring of physiological signals directly on the human body in daily life. These systems provide a unique opportunity to monitor dynamic physiological signals such as heart rate, blood oxygenation, body temperature, sweat composition, neural activity, and glucose levels with minimal patient burden, thus supporting early diagnosis, long-term disease management, and timely clinical intervention. Clinically, wearable devices are critically needed in applications such as cardiovascular disease monitoring, where real-time ECG (Electrocardiogram) and PPG (Photoplethysmography) signals can detect arrhythmias or ischemic events; diabetes care, through continuous glucose monitoring without the need for frequent finger pricks; neurological disorder management, with EEG patches for seizure tracking; and even infectious disease screening, where temperature and respiratory monitoring support early detection of febrile illnesses. These technologies also play essential roles in telemedicine, post-operative recovery, remote rehabilitation, and mental health management by enabling continuous data acquisition outside clinical settings. However, to meet real clinical needs, such systems must achieve high signal fidelity, long-term biocompatibility, mechanical comfort, robust wireless data transmission, and energy autonomy, while ensuring compliance with regulatory standards (Fig. 1).

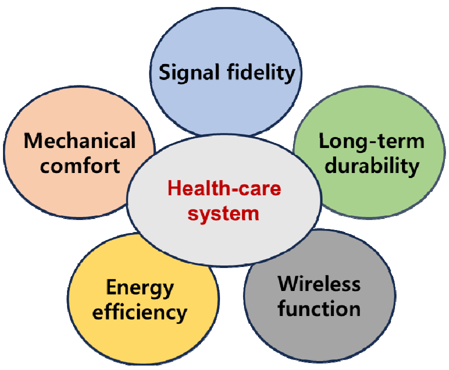


Figure 1. Standards of healthcare systems for meeting clinical needs

Devices must be soft, stretchable, and breathable to minimize skin irritation and support long-term use, especially in sensitive populations such as pediatric or elderly patients. Real-time data processing and integration with clinical decision support tools are equally important to transform raw bio-signals into actionable medical insights. Furthermore, to gain clinical trust and adoption, the sensing accuracy of wearable systems must be comparable to gold-standard medical devices, requiring optimized sensor design, noise filtering algorithms, and adaptive calibration. These requirements highlight the importance of integrating advanced materials such as conductive hydrogels, nanocomposites, and bioinspired interfaces with ergonomic and modular system design. Additionally, the incorporation of multimodal sensing capabilities (e.g., combining electrophysiological, biochemical, and mechanical signals) within a single skin-attachable platform can provide more comprehensive physiological assessments, aligning with the emerging trend toward holistic digital diagnostics. Wireless technologies, including Bluetooth Low Energy and near-field communication, enable real-time data streaming to cloud-based healthcare platforms or directly to clinicians, facilitating telemonitoring and remote diagnostics. Power management remains a critical bottleneck, necessitating the use of low-power electronics and energy harvesting strategies such as thermoelectric or triboelectric generators. The future of clinical healthcare envisions a seamless integration of such wearable systems with electronic health records and AI-based analytics to support continuous risk assessment, personalized treatment plans, and closed-loop therapeutic interventions. Moreover, the COVID-19 pandemic has underscored the urgent need for contactless, real-time monitoring solutions that can reduce the burden on healthcare infrastructure while maintaining patient safety. Skin-attachable devices, capable of tracking respiratory parameters, oxygen saturation, and body temperature, have proven particularly valuable during this global health crisis. In light of these needs, the development of next-generation wearable healthcare systems should be driven by a deep understanding of clinical use cases, patient behavior, and environmental variability. Interdisciplinary collaboration among materials scientists, engineers, clinicians, and data scientists is essential to create systems that are not only technically sophisticated but also clinically meaningful. Ultimately, skin-attachable wearable healthcare technologies are poised to become indispensable tools in the future of medicine by enabling real-time, decentralized, and patient-centered care, addressing critical clinical needs with unprecedented accessibility and precision.

Advanced materials for wearable health-care system

To meet the growing demand for high-performance wearable healthcare devices, the development of advanced materials that combine excellent electrical, mechanical, and biocompatible properties is critical. Among the most promising material classes are conducting polymers (CPs), metal-based nanofillers, and liquid-metal (LM) composites, each offering distinct advantages for seamless integration with the human body. CPs such as PEDOT:PSS, polyaniline (PANI), and polypyrrole (PPy) have attracted significant attention for their tunable electrochemical properties, stretchability, and solution-processability. In particular, PEDOT:PSS has shown exceptional electrical conductivity (up to ~2,700 $S \cdot cm^{-1}$) and mechanical ductility, with enhancements achieved through blending with supramolecular additives or flexible polymers like PVA, enabling stretchability over 100% without mechanical failure[1]. PANI and PPy-based nanocomposites also exhibit high electroactivity and mechanical robustness, with PPy hydrogels offering low impedance and high-water retention, ideal for bio-interfacing and sensing[2]. Although their electrical conductivity is generally lower than that of metals, CPs offer excellent molecular tunability, inherent softness, and skin conformability, making them key candidates for soft, biocompatible electronics. On the other hand, metal-based nanofillers such as silver nanowires (AgNWs), gold nanoparticles (AuNPs), and core-shell Ag-Au-Pt nanostructures provide ultra-high conductivity (often exceeding 10,000 $S\cdot cm^{-1}$), which is crucial for applications requiring high signal fidelity[3]. AgNWs embedded in stretchable matrices like PDMS or SEBS can achieve conductivities over 100,000 $S\cdot cm^{-1}$ and stretchability beyond 500%, making them ideal for stretchable electrodes and interconnects[4]. To mitigate the cytotoxicity of silver, gold coatings and alloyed nanostructures have been developed to enhance biocompatibility and chemical stability, with Ag-Au-Pt nanowires further suppressing ion leaching and improving longevity. These nanocomposites are vital for electrophysiological monitoring, where signal quality and mechanical durability are paramount. Meanwhile, liquid-metal composites based on eutectic gallium-indium (EGaIn) offer a unique combination of metallic conductivity and extreme deformability. When dispersed as microdroplets within elastomers, EGaIn remains electrically inactive until mechanically or optically sintered, forming percolating conductive networks. These composites can achieve conductivities in the range of 1,000–20,000 $S\cdot cm^{-1}$ while maintaining stretchability exceeding 1,000%[5]. Furthermore, LM systems inherently exhibit self-healing capabilities, strain-insensitive conduction, and low mechanical hysteresis[6]. Recent advances such as porous LM fiber mats and printable biphasic Ga-In (bGaIn) systems offer breathable and robust platforms for long-term wearable use [7]. Although encapsulation is often required to prevent leakage and oxidation, the unique properties of LMs make them highly suitable for next-generation wearable healthcare systems where high mechanical compliance and reliable performance are required. Overall, the integration of CPs, metal-based nanomaterials, and LM composites offers a versatile and multifunctional materials toolkit for advancing skin-interfaced electronics in medical and physiological monitoring applications.

Design approaches for wearable health-care system

To ensure long-term mechanical reliability and electrical performance of wearable healthcare systems under continuous and dynamic body movement, structural design strategies must accommodate significant mechanical deformation such as stretching, bending, twisting, and conforming to complex skin topography without compromising the electrical integrity of embedded components. These challenges are met through a combination of innovative geometrical engineering and materials integration, with several key design approaches emerging as particularly effective. Notable examples include serpentine interconnects, island-bridge layouts, kirigami-inspired geometries, and surface modifications to enhance biocompatibility in metallic conductors (Fig. 2).

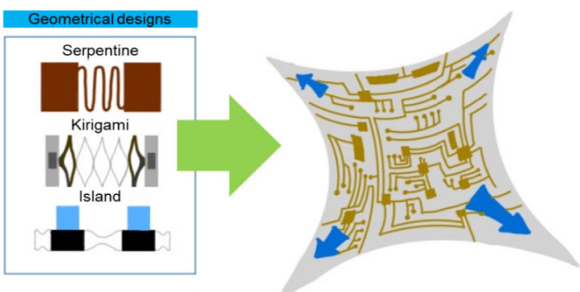


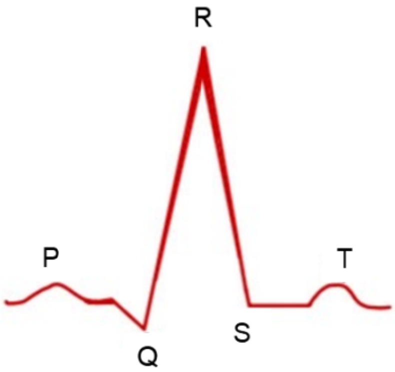
Figure 2. Diverse geometrical design for making stretchability

Serpentine interconnects represent a foundational structural motif widely adopted in soft electronic systems. These interconnects are typically composed of conductive traces patterned in sinusoidal, meandering, or spring-like shapes on ultrathin, soft elastomeric substrates. The serpentine geometry enables extreme mechanical stretchability by converting applied in-plane tensile strain into out-of-plane buckling, torsion, or rotation modes thereby reducing localized strain in the conductive paths themselves. Depending on the specific design, serpentine interconnects can accommodate strains ranging from ~100% to over 300%, while advanced self-similar and fractal-inspired designs have demonstrated stretchability exceeding 2000%, all while maintaining less than 1% change in electrical resistance. For instance, Zhang Y et al. [8] reported serpentine interconnects that sustain up to ~286% strain, while Xu et al. [9] demonstrated self-similar designs with ~300% strain and areal fill factors around 50%, offering a promising path for dense, high-performance stretchable electronics. Building on this concept, the island-bridge layout introduces a heterogeneous structural architecture, wherein rigid functional components such as integrated circuits (ICs), sensors, or power modules are mounted on “islands” that are mechanically isolated from the surrounding substrate. These islands are interconnected by flexible “bridges” composed of serpentine or zigzag conductive traces. This approach strategically localizes mechanical deformation to the interconnect regions, thereby protecting the rigid components from mechanical stress. Devices based on this strategy have demonstrated stretchability from 150% to 200% without electrical failure, as exemplified by the seminal work of Li et al. [10], who also presented extensive modeling strategies to increase stretchability.

A third strategy involves the use of kirigami-inspired geometries, which draw inspiration from the traditional Japanese art of paper cutting. This method involves introducing precisely patterned cuts or slits into otherwise rigid or brittle materials such as metal films deposited on flexible polymer substrates. These cuts create mechanical hinges or rotation points that allow the structure to expand, unfold, or bend out-of-plane under tensile strain. As a result, even non-stretchable materials can be rendered stretchable, as the cuts effectively distribute and isolate strain across the structure. Kirigami-based designs have been successfully applied to thin metal films, enabling significant deformation without fracture thus preserving electrical continuity even under large strains. The review by Han et al. [11] discusses the use of buckling and geometric patterning, including kirigami, as effective methods to achieve mechanical compliance in electronic materials traditionally considered rigid. While structural engineering addresses mechanical deformation, biocompatibility remains a critical consideration, particularly when integrating metallic conductors into skin-contacting devices. Among various conductors, silver (Ag)-based materials are widely used in wearable sensors due to their excellent electrical conductivity and reasonable mechanical compliance. However, a major concern with prolonged skin contact is the leaching of silver ions (Ag^+), which can induce cytotoxic effects, inflammation, and tissue damage commonly referred to as silver poisoning. To mitigate this issue, a thin gold (Au) shell can be coated onto silver nanowires (AgNWs), forming core–shell nanostructures. This strategy significantly suppresses Ag^+ ion release and enhances oxidative stability, while preserving high conductivity and mechanical stretchability. Notably, such hybrid conductors offer a cost-effective compromise compared to using pure gold materials, delivering enhanced performance without the prohibitive material cost. Supporting this approach, the work by Park et al. [12] demonstrates that coating silver nanowires with a uniform gold layer significantly reduces sheet resistance (to ~8.3 Ω/sq) and improves durability under strain up to 80%. More importantly, the gold shell suppresses oxidation and Ag^{+} ion leaching, enhancing chemical stability and biocompatibility making it a practical and cost-effective alternative to fully gold-based stretchable electrodes. In summary, the mechanical resilience and functional performance of skin-interfaced wearable healthcare systems are increasingly determined by the synergy between geometrical design and materials innovation. Serpentine interconnects and island-bridge configurations allow devices to deform harmoniously with the skin while preserving electrical function; kirigami-based strategies extend this adaptability to otherwise rigid materials; and biocompatibility-enhancing surface treatments ensure safety and long-term usability. Together, these approaches provide a robust framework for developing next-generation wearable electronics that can operate reliably under the mechanical and biochemical challenges of the human body.

Physiological sensors in wearable health-care system

Physiological sensors serve as the primary interface between the human body and wearable health-monitoring systems, enabling the transduction of diverse biological signals including cardiac electrical activity, brain waves, respiration, oxygen saturation, glucose concentration, and body temperature into measurable electrical data for real-time health assessment. As a widely used method, electrocardiography (ECG) captures the heart's electrical activity via skin-attached electrodes, with diagnostic interpretation based on P, QRS, and T waveforms. Clinically relevant parameters include the PR interval (0.12–0.20 s) and QT interval (0.20–0.40 s), with typical signal frequencies spanning 0.05–120 Hz and amplitudes in the millivolt range (Fig. 3).



(Figure 3. Typical form of electrocardiography signal consisting of P, QRS, T

Photoplethysmography (PPG) employs LED–photodiode optical systems to estimate blood volume changes and pulse characteristics, revealing systolic and dicrotic peaks within the 0.5–4 Hz range. Electroencephalography (EEG) measures brain electrical activity through scalp electrodes, characterizing neural oscillations across delta (0.5–4 Hz), theta (4–7 Hz), alpha (8–12 Hz), beta (13–30 Hz), and gamma (25–140 Hz) bands. Other vital parameters commonly monitored include heart rate, most accurately derived from ECG or PPG; respiration rate, typically 12–16 breaths per minute in healthy adults and measurable via chest movement or impedance pneumography; blood pressure, still predominantly obtained via cuff-based methods but increasingly estimated through cuffless techniques such as pulse transit time; and blood oxygen saturation (SpO_2), determined optically via dual-wavelength PPG (660 nm and 905 nm) with healthy ranges of 95–100%. Blood glucose levels, reported in mg/dL or mmol/L, are critical for diagnosing and managing normal, prediabetic, and diabetic states, while body temperature whether measured at the skin or core reflects both physiological regulation and environmental influences. Modern wearable platforms increasingly integrate multiple sensing modalities (e.g., ECG, PPG, SpO_2, temperature, and biochemical sensors) into a single device, enabling comprehensive and continuous health monitoring. Coupled with IoT-based wireless connectivity, these systems facilitate remote diagnostics and data-driven analytics, providing robust tools for real-time, multi-parameter health tracking. Recent advances in artificial intelligence have further enhanced the clinical value of physiological wearables, enabling personalized, continuous anomaly detection without extensive manual labeling. A notable example is "AI on the Pulse"[13], introduced in August 2025, which integrates wearable sensing, ambient intelligence, and a universal time-series model (UniTS) to establish individualized physiological baselines and detect subtle deviations in real time across devices ranging from high-fidelity ECG monitors to consumer-grade smartwatches. This system demonstrated a ~22% improvement in F1 score over 12 state-of-the-art detection methods. By leveraging large language models, it also translates technical alerts into clinically meaningful narratives for caregivers, and has been successfully deployed in real-world home-care environments.

Conclusion

Wearable skin-attachable healthcare systems have been changed rapidly from conceptual prototypes to functional platforms capable of transforming the delivery of healthcare. By integrating advances in materials science, structural engineering, and system-level design, these technologies now offer the potential for continuous, real-time, and non-invasive monitoring of a wide range of physiological parameters in natural, everyday environments. Material innovations, such as intrinsically stretchable conductors, biocompatible substrates, conductive polymers, have enabled devices that conform intimately to skin while maintaining mechanical durability and stable electrical performance under repeated deformation. Concurrently, structural design strategies, including serpentine interconnects, island-bridge layouts, and breathable multilayer interfaces, have improved both wear ability and long-term comfort. Physiological sensors embedded in these platforms now support multi-modal data acquisition, capturing electrophysiological, biochemical, and physical signals with increasing precision. When combined with wireless communication modules, low-power electronics, and AI-assisted analytics, such systems provide actionable health insights beyond the constraints of traditional hospital-based diagnostics. These capabilities are poised to improve chronic disease management, enhance post-operative recovery monitoring, and support preventive healthcare in aging populations. Despite these advances, significant challenges remain, including ensuring reliable long-term skin adhesion without irritation, developing power solutions that support extended untethered operation, and establishing clinically validated data interpretation frameworks. Furthermore, large-scale clinical trials, standardized testing protocols, and regulatory pathways will be essential for translating laboratory achievements into widely adopted medical devices. Looking forward, the convergence of soft, bio-integrated materials, intelligent signal processing, and user-centric design will be critical in realizing the full potential of skin-attachable wearable systems. By addressing current technical and translational barriers, the next generation of wearable health-care electronics can serve not merely as diagnostic tools, but as integral components of personalized, decentralized, and data-driven healthcare ecosystems.

Acknowledgement: I would like to thank Jongwook Lee and Sunny Kim for their support, encouragement during process of this review paper

REFERENCES

1. Yang, Y., Deng, H. and Fu, Q. (2020). Recent progress on PEDOT:PSS based polymer blends and composites for flexible electronics and thermoelectric devices. *Materials Chemistry Frontiers*, 4(11), 3130–3152.
2. Liu, D., Huyan, C., Wang, Z., Guo, Z., Zhang, X., Torun, H., Mulvihill, D., Xu, B.B. and Chen, F. (2023). Conductive polymer based hydrogels and their application in wearable sensors: a review. *Materials Horizons*, 10(10), 2800–2825.
3. Choi, S., Han, S.I., Jung, D., Hwang, H.J., Lim, C., Bae, S., Park, O.K., Tschabrunn, C.M., Lee, M., Bae, S.Y., Yu, J.W., Ryu, J.H., Lee, S.W., Park, K., Kang, P.M., Lee, W.B., Nezafat, R., Hyeon, T. and Kim, D.-H. (2018). Highly conductive, stretchable and biocompatible Ag–Au core–sheath nanowire composite for wearable and implantable bioelectronics. Nature Nanotechnology, 13(11), 1048–1056.
4. Jung, D.-J., Lim, C., Shim, H.J., Kim, Y., Park, C., Jung, J., Han, S.I., Sunwoo, S.-H., Cho, K.W. and Kim, D.-H. (2021). Highly conductive and elastic nanomembrane for skin electronics. Science, 373(6558), 1022–1026.
5. Lee, S., Jaseem, S.A., Atar, N., Wang, M., Kim, J.Y., Zare, M., Kim, S., Bartlett, M.D., Jeong, J.-W. and Dickey, M.D. (2025). Connecting the dots: sintering of liquid metal particles for soft and stretchable conductors. Chemical Reviews, 125(6), 3551–3585.
6. Lee, W., Kim, H., Kang, I., Park, H., Jung, J., Lee, H., Park, H., Park, J.S., Yuk, J.M. and Kang, J. (2022). Universal assembly of liquid metal particles in polymers enables elastic printed circuit board. Science, 378(6620), 637–641.
7. Zhang, B., Li, J., Zhou, J., Chow, L., Zhao, G., Huang, Y., Ma, Z., Zhang, Q., Yang, Y., Yiu, C.K., Chun, F., Huang, X., Gao, Y., Wu, P., Jia, S., Li, H., Li, D., Liu, Y., Yao, K., Shi, R., Chen, Z., Khoo, B.L., Yang, W., Wang, F., Zheng, Z., Wang, Z. and Yu, X. (2024). A three-dimensional liquid diode for soft, integrated permeable electronics. Nature, 628(8009), 604–611.
8. Zhang, Y., Fu, H., Su, Y., Xu, S., Cheng, H., Fan, J.A., Hwang, K.-C., Rogers, J.A. and Huang, Y. (2013). Mechanics of ultra-stretchable self-similar serpentine interconnects. *Acta Materialia*, 61(18), 7652–7660.
9. Zhang, Y., Wang, S., Li, X., Fan, J.A., Xu, S., Song, Y.M., Choi, K.J., Yeo, W.H., Lee, W., Nazaar, S.N., Lu, B., Yin, L., Hwang, K.-C., Rogers, J.A. and Huang, Y. (2014). Experimental and theoretical studies of serpentine microstructures bonded to prestrained elastomers for stretchable electronics. *Advanced Functional Materials*, 24(14), 2028–2037.
10. Li, K., Shuai, Y., Cheng, X., Luan, H., Liu, S., Yang, C., Xue, Z., Huang, Y. and Zhang, Y. (2022). Island effect in stretchable inorganic electronics. *Small*, 18(17), 2107879–2107879.
11. Han, S.H., Shin, J.H., Yang, H.J., Nam, S., Park, J.Y. and Choi, S.S. (2024). Optical visualization of stretchable serpentine interconnects using chiral liquid crystal elastomers. Advanced Science, 11(14), 202408346–202408346.
12. Park, H., Kim, S., Lee, J., Kim, K., Na, H., Kim, Y., Kim, D., Shin, D., Kim, B. and Sim, K. (2024). Facile strategy for uniform gold coating on silver nanowires embedded PDMS for soft electronics. npj Flexible Electronics, 8, 28–28.
13. Gabrielli, D., Velardi, P., Prenkaj, B. and Faralli, S. (2025). AI on the Pulse: Real-Time Health Anomaly Detection with Wearable and Ambient Intelligence. *arXiv preprint*, arXiv:2508.03436.

****