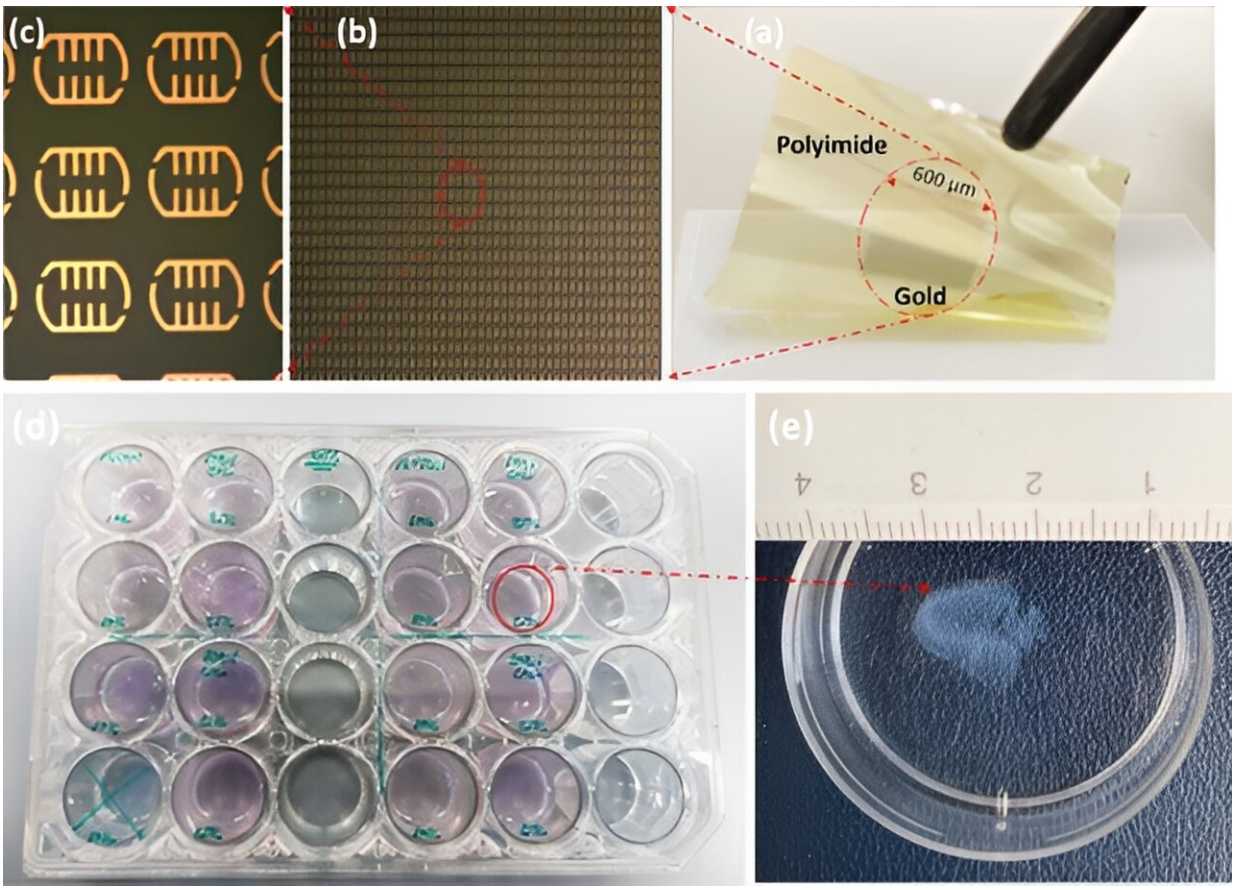
Terahertz biosensor detects skin cancer with remarkable accuracy, advancing new era of early detection

February 20 2024



Credit: *IEEE Transactions on Biomedical Engineering* (2024). DOI: 10.1109/TBME.2024.3364386

Researchers have developed a revolutionary biosensor using terahertz (THz) waves that can detect skin cancer with exceptional sensitivity, potentially paving the way for earlier and easier diagnoses. Published in *IEEE Transactions on Biomedical Engineering,* the study presents a significant advancement in early cancer detection, thanks to the collaboration of multidisciplinary teams from Queen Mary University of London and the University of Glasgow.

"Traditional methods for detecting skin cancer often involve expensive, time-consuming, CT, PET scans and invasive higher frequencies technologies," explains Dr. Shohreh Nourinovin, Postdoctoral Research Associate at Queen Mary's School of Electronic Engineering and Computer Science, and the study's first author. "Our biosensor offers a non-invasive and highly efficient solution, leveraging the unique properties of THz waves—a type of radiation with lower energy than X-rays, thus safe for humans—to detect subtle changes in cell characteristics."

The key innovation lies in the biosensor's design. Featuring tiny, asymmetric resonators on a flexible substrate, it can detect subtle changes in the properties of cells. Unlike traditional methods that rely solely on refractive index, this device analyzes a combination of parameters, including resonance frequency, transmission magnitude, and a value called "full width at half maximum" (FWHM). This comprehensive approach provides a richer picture of the tissue, allowing for more accurate differentiation between healthy and cancerous cells and to measure malignancy degree of the tissue.

In tests, the biosensor successfully differentiated between normal skin cells and basal cell carcinoma (BCC) cells, even at different concentrations. This ability to detect early-stage cancer holds immense potential for improving patient outcomes.

"The implications of this study extend far beyond skin cancer detection," says Dr. Nourinovin. "This technology could be used for early detection of various cancers and other diseases, like Alzheimer's, with potential applications in resource-limited settings due to its portability and affordability."

Dr. Nourinovin's research journey wasn't without its challenges. Initially focusing on THz spectroscopy for cancer analysis, her project was temporarily halted due to the COVID-19 pandemic. However, this setback led her to explore the potential of THz metasurfaces, a novel approach that sparked a new chapter in her research.

Professor Qammer H. Abbasi, Co-director for Communication Sensing & Imaging Hub at University of Glasgow's James Watt School of Engineering, said, "Integrating terahertz imaging technology into this type of flexible, portable, reuseable sensor could make cancer screening a quicker and more comfortable procedure for patients. We're excited to build on the potential of this breakthrough technology with future collaborative research."

"Despite the initial difficulties, the potential impact of this technology kept us motivated," says Professor Akram Alomainy, Head of the Antennas & Electromagnetics Research Group at Queen Mary. "We believe this biosensor has the potential to save countless lives by enabling early detection and intervention for various cancers."

More information: Shohreh Nourinovin et al, Highly Sensitive Terahertz Metasurface Based on Electromagnetically Induced Transparency-Like Resonance in Detection of Skin Cancer Cells, *IEEE Transactions on Biomedical Engineering* (2024). DOI: 10.1109/TBME.2024.3364386

Medical Xpress

Provided by Queen Mary, University of London

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