Hybrid Graphene for The Development of Next Generation Cancer Screening Device and Chiral Spintronics Applications

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Abstract
A new breakthrough has been achieved in the design and characterization of spatiotemporal nano-/micro-structural arrangements that have opened up new horizons in graphene based sensor applications, including ultra-fast and on-site biopsy-decision-making for intraoperative surgical oncology, wearable-spectrometry, and spin controlled chiral molecule identification.[1,2] The spatiotemporal sensing arrangement is achieved through the use of scalable, binder-free, functionalized hybrid spin-sensitive (<↑| or <↓|) graphene-ink printed sensing layers on free-standing films made of porous, fibrous, and naturally helical cellulose based quantum sieve in a hierarchically stacked geometrical configuration (HSGC) inspired by butterfly wings. The HSGC operates according to a time-space-resolved architecture that modulates the mass-transfer rate for the separation, elution, and detection of each individual compound within a mixture of various volatile organic compound (VOCs), thus providing a mass spectrogram. The HSGC has the potential to be used in a wide range of applications, including the fast and real-time generation of a spectrogram of VOCs during liquid-biopsy, without the need for any immunochemistry-staining and complex power-hungry cryogenic machines. It can be used for wearable spectrometry that provides a spectral signature of molecular profiles emitted from the skin during various dietary conditions. Furthermore, such spin sensitive detectors could be used for chiral spintronics and quantum computing applications. The applications studied are presented schematically in Figure 1.

References

[1] A. Maity, Y. Milyutin, V. D. Maidantchik, Y. H. Pollak, Y. Broza, R. Omar, Y. Zheng, W. Saliba, T. P. Huynh, H. Haick *Adv Sci*. 2022; 9(34), e2203693. doi: 10.1002/advs.202203693

[2] A. Maity, Y. H. Pollak, R. Gupta, W. Wu, H. Haick (2023), Spin-Controlled Helical Quantum Sieve Chiral Spectrometer. *Adv. Mater*. 2023, e2209125. doi: 10.1002/adma.202209125.

Figures

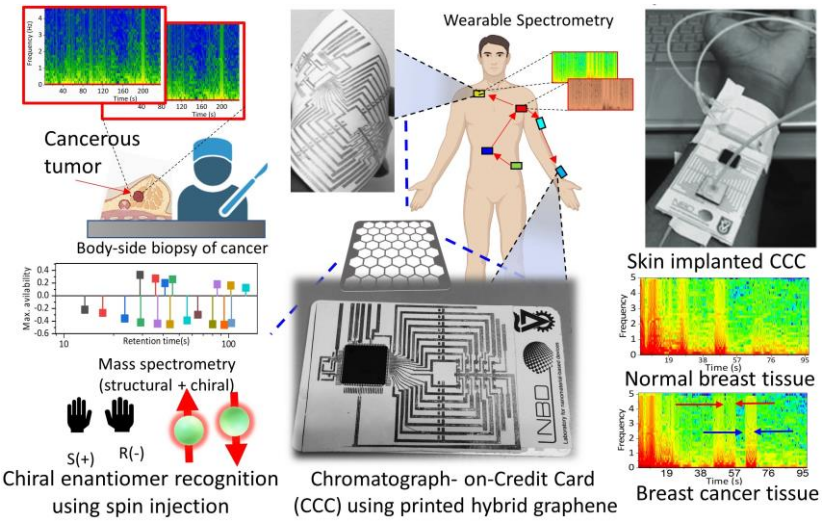

Figure 1: Hybrid Graphene based HSGC integrated on paper for cancer spectrometry, spin sensitive chiral recognition, clinical, medical, and wearable spectrometer applications.