Ultrasensitive gas detection empowered by synergy of graphene and sub-comb dynamics

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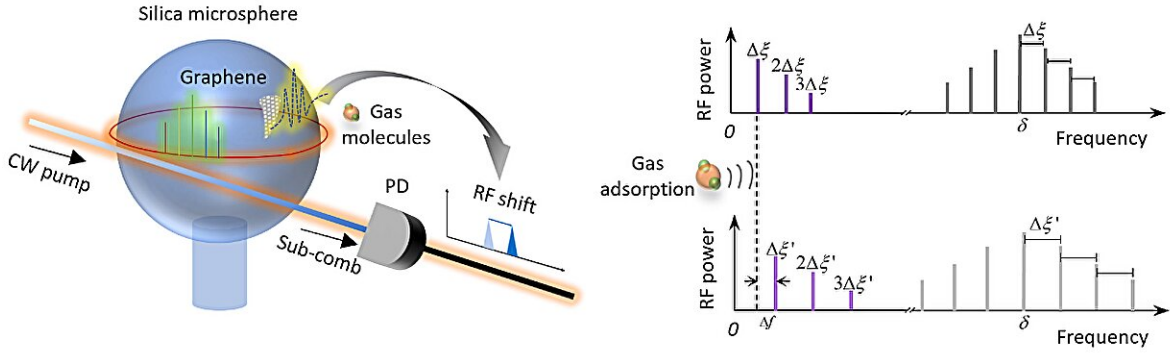

Embodiment and operating principle of graphene-sensitized sub-comb sensing. Credit: Yupei Liang, Mingyu Liu, Fan Tang, Yanhong Guo, Hao Zhang, Shihan Liu, Yanping Yang, Guangming Zhao, Teng Tan, Baicheng Yao

Since the inception of microcomb, whose generation relies on Kerr nonlinearity in microresonator, the coherent soliton state has attracted intense research. Although the operation of sub-comb outputs is straightforward, as a noncoherent comb state, it was often overlooked in previous techniques.

With graphene sensitization, this sub-comb heterodyne sensing device exhibits an exceptional response to gas molecular adsorption, achieving detect limits of 1.2 ppb for H_2S gas and 1.4 ppb for SO_2 gas, respectively.

Research, led by Prof. Baicheng Yao at University of Electronic Science and Technology of China (UESTC), synergizes flexible comb formation, direct offset heterodyne detection, and graphene optoelectronics, leading to an easily operated, ultrasensitive miniature gas sensor. The work, titled "Harnessing sub-comb dynamics in a graphene-sensitized microresonator for gas detection," was published in *Frontiers of Optoelectronics*.

This exploration not only offers a simple system configuration but also sets a new standard for convenient optoelectronic detection. Looking ahead, beyond its application in microsphere-based gas sensing, the interdisciplinary approach shows promise for providing platform-independent solutions for a broader range of sensing applications, including on-chip biochemical sensing and photonic-microwave signal generation and control.

Researchers led by Prof. Baicheng Yao are interested in optical fiber sensors and frequency comb, where the fiber sensors' own miniature size and frequency comb boast exceeding exactitude and steadiness.

Their idea is to start with leveraging the formation dynamics of sub-comb state, which can be easily accessed and offers steady and detectable beacon for gas sensing. Under the sensitization effect of graphene, the beacon is activated and shows exceptional response for analytes.

More information: Yupei Liang et al, Harnessing sub-comb dynamics in a graphene-sensitized microresonator for gas detection, *Frontiers of Optoelectronics* (2024). DOI: 10.1007/s12200-024-00115-5

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