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Terahertz ultra-high sensitive grooved-microfluid bio-sensors for label-free detection of circulating tumor cell

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Conventional biological detection methods, such as polymerase chain reaction (PCR), fluorescence microscopy (EFM) and flow cytometry (FC) are characterized by long process, high cost, complex procedures and limited sensitivity. Due to the non-invasive probe, unique finger prints, on-chip scale, and label free properties, terahertz (THz) biosensing technology has shown great potential in highly sensitive and on-site detection of minute amounts of microbial substances, single tumor cells, and DNA components. For the ultra-slow abundance of circulating tumor cells (CTCs) in blood samples, biosensor needs a sharp edge in responsive spectrum and high concentration of electromagnetic field to detect small changes in the dielectric environment. Up to date, terahertz metamaterial (MM) biosensors have realized single molecule and micromole detection, but the sensitivity is still limited by the weak light-matter interaction. Besides, the quantitative detection of liquid biomolecule in combination with biological specificity research is obviously insufficient. By constructing a hybrid Fano resonant metallic microstructure array-insulator-metal (MIM) configuration, a novel THz absorptive grooved-microfluid interaction metamaterial cavity (AGMIMC) sensor is proposed here. Two types of dual-band resonators are characterized primarily. The normalized sensitivities of symmetric paired ring resonators (SPRR) and asymmetric split ring resonators (ASRR) are 0.74/RIU at 0.77 THz and 0.76/RIU at 0.543 THz, respectively. Furthermore, the strong light-harvesting sensing mechanism is elucideted by both near field coupling and Gap plasmon interaction theory. Compared with other MM-based terahertz sensors, the proposed MM perfect absorber (MPA) sensor with significantly confined field and enhanced sensitivity is much more suitable for label-free terahertz probing of fluidic biological matter.

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