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Optimization of Two-Dimensional Plasmonic Absorbers Based on a Metamaterial and Cylindrical Cavity Model Approach for High-Responsivity Wavelength-Selective Uncooled Infrared Sensors

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The absorption characteristics of a two-dimensional plasmonic absorber (2D-PLA) were investigated to realize a high-performance uncooled infrared (IR) sensor. Theoretical calculations and sensor measurements indicate a threshold for the filling factor of the ratio of the dimple diameter to the period of the 2D-PLA to obtain sufficient absorption over 80%. Two theoretical approaches were used to determine the absorption threshold: the plasmonic metamaterial approach and the cylindrical cavity model. The mode analysis of the cylindrical cavity resonator demonstrated that the minimum resonant mode gives a good explanation of the absorption threshold, and the filling factor of over 60% confirms that sufficient absorption can be achieved. The strong absorption occurs due to the hybridization of the spoof surface plasmon mode and cavity resonance by periodic dimples. The results obtained here provide an important and general design principle for the realization of high-responsivity uncooled IR sensors in the wideband IR wavelength region.

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