Polariton-assisted electrical detection of gases in Van der Waals heterostructures

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Two-dimensional materials such as Graphene and hBN have shown great advances in the field of sensing owing to their intriguing optical properties, which are exhibited by their respective polaritons in the Mid-Infrared (MIR) range **[1]**. So far, optical sensing in these materials has been achieved via nano-patterning either the 2D materials or their environment, which limits the polaritons to low quality factors or necessitates the use of complex nano-fabrication techniques, respectively **[2,3]**. In addition, the need of an external optical detector makes the integration of the sensors very challenging. By integrating polaritonic launchers to our single layer graphene and hBN VdW heterostructure, our gas sensor eliminates the need of an additional detector due to the capability of graphene to electrically detect polaritons. Our sensing platform is based on polaritonic interaction with gases having their vibrational resonances in the MIR, due to which the gas sensor does not require an additional functionalization layer, thus providing a scope for detecting multiple gases in the MIR range. In this work, we have experimentally detected Volatile Organic Gases (VOCs) such as Acetone and IPA in a single sensing device. The ability to completely reconstruct the absorption spectrum of these gases in the MIR range corroborates its capability of sensing multiple gases with high degree of selectivity. The Limit of Detection (LOD) for acetone gas with our proposed polaritonic gas sensor achieved small concentration values as low as 2.8ppm with a very fast sensing response of < 3s. Our capability to electrically detect ~200 molecules of acetone gas in the active region at the LOD constitutes a step forward in potentially reaching parts per billion sensitivity. Moreover, the capability to detect gases with electrical readout is a promising platform for on chip integration of the polaritonic gas sensor.

References

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