Engineered Diamond Surfaces & Heterostructures: Sensors for Environmental Monitoring and Life Science Applications

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Diamond films grown by chemical vapor deposition exhibit a remarkable combination of properties advantageous for sensing applications, including tunable surface functionalities, high chemical stability, semiconductor behavior, and biocompatibility. This study briefly reviews recent advances in tailoring the plasma properties, gas composition, pressure, and temperature during microwave plasma CVD growth of diamond films to control the resulting film properties for gas and biosensing [1].

Hydrogen-terminated diamond surfaces induce a highly sensitive two-dimensional hole gas that enables room-temperature detection of oxidizing (NO_2) and reducing (NH_3) gases [2,3]. The influence of nanostructured surface morphology on the gas sensor response will be discussed. Benchmarking against commercial SnO_2 layers elucidates the distinct sensing mechanisms operative for H-terminated diamonds, especially in a heterostructure with 2D materials (MoS_2 or GO).

Furthermore, diamond surface terminations and morphologies critically impact the patterned adhesion of cell lines, a crucial consideration for bioelectronic applications. Label-free cell detection is demonstrated using diamond-based field-effect transistors, providing insights into real-time monitoring capabilities and sensor performance metrics like sensitivity, stability, and reliability. Novel biosensing principles based on impedance, optical, and mass transduction modes using diamond devices will be presented [4,5].

The scientific findings highlight the potential of engineered diamond films as a multifunctional material platform for advanced chemical and biological sensing [6,7] by elucidating key structure-property relationships that govern sensing performance.

References

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