Raman Variability in CVD-Grown $PtSe_2$ with Drop-Cast Gold Nanoparticles

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Two-dimensional transition metal dichalcogenides (TMDs) grown by chemical vapor deposition (CVD) offer controlled thickness, high uniformity, and well-defined interfaces, making them suitable platforms for studying structure–property relationships. In particular, $PtSe_2$ exhibits strong layer-dependent Raman response and tunable electronic properties [1], making it a suitable platform for studying material-specific optical variability, with potential relevance to hardware security concepts such as physical unclonable functions (PUFs) [2].

In this work, we investigate Raman and surface-enhanced Raman spectroscopy (SERS) response of CVD-grown few-layer $PtSe_2$ thin films deposited on sapphire substrates and modified with plasmonic gold nanoparticles prepared using different surface chemistries (CTAB- and citrate-based) and deposited via drop-casting. Spatially resolved Raman/SERS mapping is combined with morphological characterization to analyze correlations between local structure, nanoparticle distribution, and optical response.

The obtained results indicate weak and spatially non-uniform SERS response, potentially related to surfactant-mediated spacing of nanoparticles from the $PtSe_2$ surface, which may suppress or localize plasmonic coupling. We analyze correlations between nanoparticle distribution, surface morphology, and Raman response, with particular emphasis on the influence of surface chemistry and nanoparticle adsorption.

Rather than focusing solely on signal amplification, this work highlights the importance of spatial variability and material-specific response in $PtSe_2$ systems. Even weak and spatially non-uniform Raman response may reflect material-specific optical variability, relevant to the concept of physically unclonable features.

These results provide insight into the limitations of SERS in well-defined 2D material systems and contribute to the understanding of interface-driven optical effects in $PtSe_2$-based heterostructures.

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References

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