

## CTAB VS SIGNAL: WHY AUNPS DO NOT ENHANCE RAMAN RESPONSE OF PtSe<sub>2</sub> IN DROP-CAST SYSTEMS

**P. Kałuziak<sup>1,\*</sup>, J. Raczyński<sup>1</sup>, Ł. Majchrzycki<sup>1</sup>, M. Szczęsny<sup>2</sup>, S. Gawinkowski<sup>3</sup>, D. Larowska-Zarych<sup>3</sup>, S. El-Ahmar<sup>1</sup>, W. Koczorowski<sup>1</sup>**

<sup>1</sup>*Institute of Physics, Poznan University of Technology, Piotrowo 3, 61-138 Poznan, Poland*

<sup>2</sup>*Institute of Materials Research and Quantum Engineering, Poznan University of Technology, Piotrowo 3, 61-138 Poznan, Poland*

<sup>3</sup>*Institute of Physical Chemistry PAS, Kasprzaka 44/52, 01-224 Warsaw, Poland*

\* corresponding author: [piotr.kaluziak@doctorate.put.poznan.pl](mailto:piotr.kaluziak@doctorate.put.poznan.pl)

Plasmonic modification of Raman response using gold nanoparticles (AuNPs) is widely investigated as a strategy to enhance sensitivity in two-dimensional (2D) material systems [1,2]. Such hybrid platforms are considered for applications requiring spatially heterogeneous spectral responses, including Physical Unclonable Features (PUFs).

In this work, we examine the Raman response of PtSe<sub>2</sub> modified with AuNPs deposited via drop casting, focusing on the mutual interaction between plasmonic effects and nanoparticle surface chemistry. Contrary to expectations, no clear enhancement of characteristic PtSe<sub>2</sub> Raman modes is observed. Instead, the spectra exhibit additional low-frequency features, which can be attributed to ligand-related vibrations or Au–halide interactions associated with CTAB-stabilized nanoparticles [3–4]. Spatially resolved Raman mapping reveals that these contributions are highly localized and correlate with nanoparticle-rich regions, indicating that surface chemistry can dominate over electromagnetic enhancement. As a result, the presence of AuNPs leads to modification and, in some cases, masking of the PtSe<sub>2</sub> spectral response rather than its amplification. These findings highlight a key limitation of CTAB capped AuNPs in drop-cast configurations for Surface-Enhanced Raman Spectroscopy (SERS) studies of 2D materials. The results highlight the key role of ligand chemistry in determining the observed signal.

This work was supported by the Ministry of Education and Science (Poland) under Project No. 0512/SBAD/2620 and the PhDBoost Program (No. 0512/SPHD/2601).

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