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Fingerprinting 2-Dimensional Polar Metals

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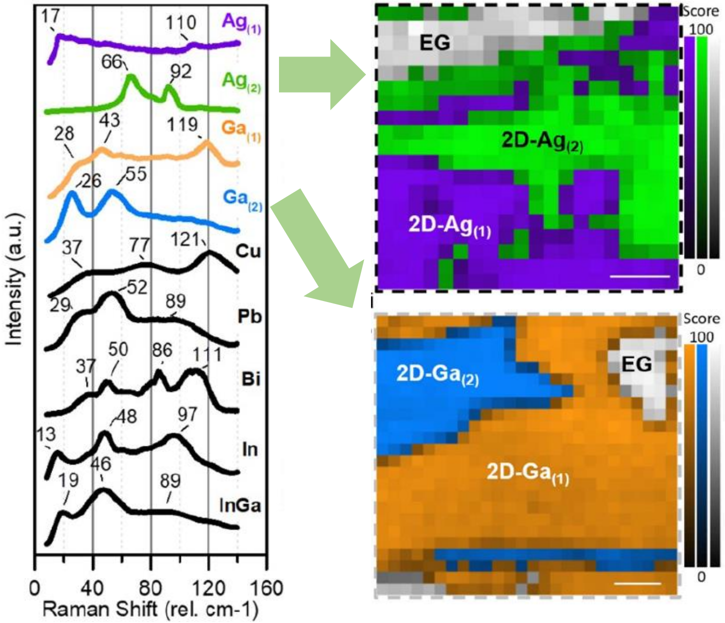
Project Summary: The intercalation of a molecule or ion in a layered structure is key to enhancing energy storage, material conductivity, intercalant structural ordering, and the formation of two-dimensional (2D) superconducting states. The process of intercalation modifies the vibrational energy of the host, which can be monitored non-invasively by Raman spectroscopy. However, the detected Raman spectral shifts may originate from a variety of phenomena, generally making the technique an indirect means of identifying intercalation success. In this highlight, we identified newly discovered low-frequency (LF) (<100 cm^{-1}) Raman features due to the formation of unique 2D polar metals (Ag, Cu, Pb, Bi, Ga, In) or metal alloys (In_xGa_{1-x}) intercalated at an epitaxial graphene (EG)/silicon carbide (SiC) interface and demonstrate that 2D-Ag and 2D-Ga can have spatially distinct phases with their own unique Raman responses. Additionally, we establish that the 2D-Ga exhibits a structural evolution as a function of temperature, independent of the SiC and EG, that can lead to nucleation of secondary phases. The newly identified LF Raman responses discussed here lay the foundation for rapid, direct, and spatially resolved evaluation of 2D polar metals in ambient. Results are published in 2D Materials, 8 041003 (2021)

2DCC Role: The 2DCC provided epitaxial graphene substrates for the formation of the 2D metals.



Each 2D-metal exhibits a unique low-frequency Raman feature, with both 2D-Ag and 2D-Ga showing two spatially distinct responses. These unique features enable spatially resolved mapping of 2D metals, significantly reducing the feedback time for understanding layer uniformity.