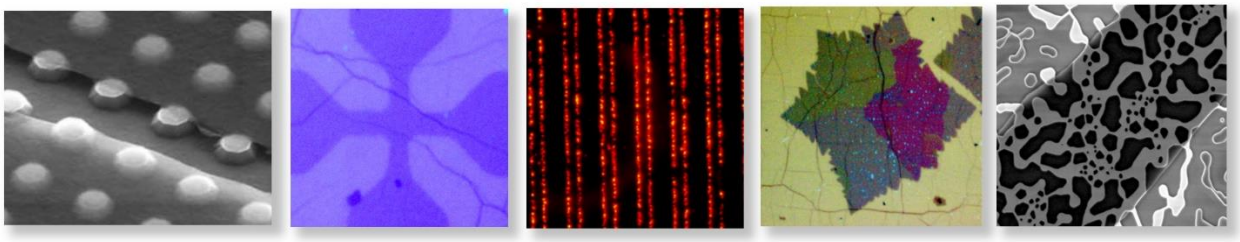
Special Seminar

Monday, September 19, 2022
1 pm
WSI, Seminar room S 101

“Engineering layered materials”

Layered 2D materials offer new opportunities to study interactions at the limit of planar material thinness and show promise for incorporation into new technologies or to enhance device performance in existing systems. In this talk I will give a brief overview of some of our past R&D efforts at the Naval Research Laboratory in studying and manipulating layered 2D materials for applications ranging from chemical sensing to nanomechanical platforms [1].

In the remaining time, I will discuss two recent research efforts: (i) Remote quantum emission in 2D semiconductors on porous metallic networks [2], and (ii) Acoustic cavities based on layered materials [3]. In the first project I will describe nuances of the gold/TMD interface and highlight a new discovery that 2D monolayers can seed a ‘reverse epitaxial’ force onto relatively thick metal films. The resulting crystallographically aligned, porous metal frameworks support suspended 2D semiconductor layers, as well as propagating SPPs that can re-excite excitons in the 2D semiconductors. In the second project, I will discuss coherent longitudinal acoustic phonon (CLAP) generation in 2D materials and will describe high frequency, high quality factor (Q) 2D acoustic cavities operating in the 50-600 GHz frequency (f) range with f x Q products up to 1×1014. We show how cavity functionality can be engineered through the introduction of heterogeneities (e.g., steps and interfaces), and we demonstrate frequency-comb generation in MoS2/hBN and strongly coupled cavities in MoS2/hBN/MoS2 heterostructures. Our theoretical and experimental results highlight that around 100 GHz, the acoustic phonon lifetimes approach their theoretical limit defined by the lattice anharmonicity.



[1] Nano Letters 8, 3137 (2008); Nano Letters 8, 3441 (2008); Nano Letters 10, 3001 (2010); PRL 109, 186807 (2012); Nano letters 12, 4212 (2012); ACS Nano 7, 637 (2013); Sci Rep 8, 2006 (2018)
[2] J.J. Fonseca et al., “Enabling remote quantum emission in 2D semiconductors via porous metallic networks”, Nature Communications 11, 5 (2020)
[3] M. K. Zalalutdinov et al., “Acoustic cavities in 2D heterostructures”, Nature Communications 12, 3267 (2021).

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