Nanoparticles of van der Waals materials with tunable size, shape and crystallinity for nanophotonic applications

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Two-dimensional (2D) van der Waals (vdW) materials have captured significant attention in scientific research due to their distinctive properties, which hold promise for next-generation electronic and optoelectronic devices [1]. However, the practical application of 2D materials in photonics faces limitations related to their form-factor – whether they are exfoliated flakes or grown through chemical vapor deposition (CVD) and epitaxial processes. At the same time, most effective way to manipulate light at the nanoscale involves interaction with nanostructured materials. Therefore, nanostructuring vdW materials offers a compelling avenue to advance nanophotonics by expanding its material database [2]. In recent years, diverse approaches have been explored to nanostructure anisotropic vdW crystals, resulting in the creation of nanophotonic devices such as waveguides, nanoantennas, and metasurfaces [3-5]. However, these approaches inherently lack the capability to form spherical substrate-free nanoparticles (NPs) from layered vdW crystals. Recently, this challenge was overcome by employing femtosecond (PLAL) technique to produce resonant NPs from MoS2 and WS2 both representing the class of transition metal dichalcogenides [6-7]. Our work demonstrates the feasibility of transforming a wide range of vdW crystals into colloidal nanoparticles with precise control over composition, shape, size, and crystalline structure.

References

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Figures

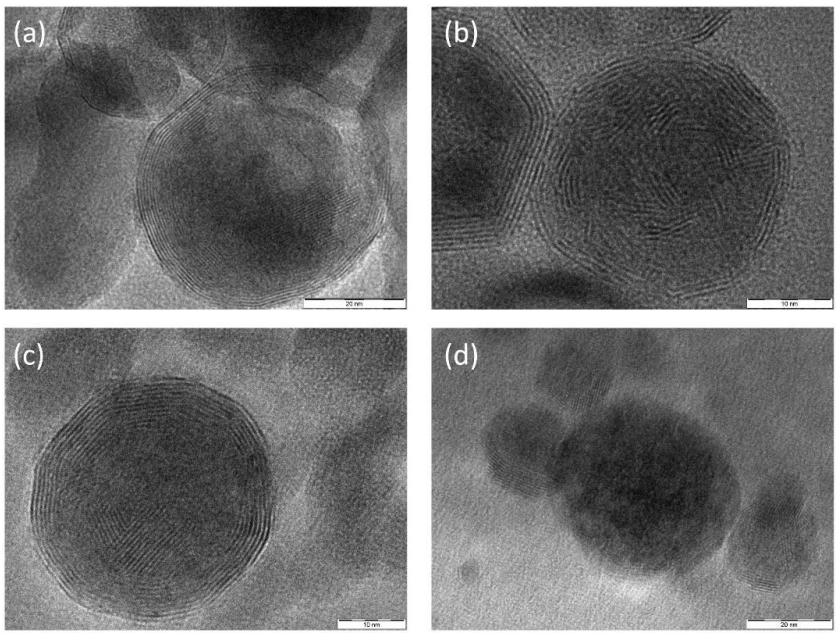

Figure 1: TEM images of colloidal (a) MoS_2, (b) WS_2, (c) $MoSe_2$ and (d) WSe_2 NPs produced by fs PLAL technique in deionized water.