Large-area epitaxial synthesis of 2D ferromagnetic van der Waals heterostructures with Curie temperature above 300 K

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Van der Waals heterostructures combining (above) room temperature layered ferromagnets and other two-dimensional (2D) crystals such as graphene and transition metal dichalcogenides are promising building blocks for the realization of ultra-compact spintronic devices with integrated magnetic, electronic and optical functionalities. In this contribution, I will present an overview of our recent achievements on scalable growth of the 2D ferromagnetic metal $Fe_{5-x}GeTe_2$ (FGT, $0 \leq x \leq 2$) on single crystalline graphene (on SiC) and WSe_2 (on Al_2O_3) templates via molecular beam epitaxy. Structural studies reveal epitaxial FGT thin films exhibiting very good surface morphology and crystalline quality. Importantly, magneto-transport measurements and SQUID magnetometry show ferromagnetic order that can persist above 350 K, which is higher than what is usually observed for flakes exfoliated from bulk crystals. These results are an important advance beyond non-scalable flake exfoliation and stacking, and constitute a crucial step towards practical applications.