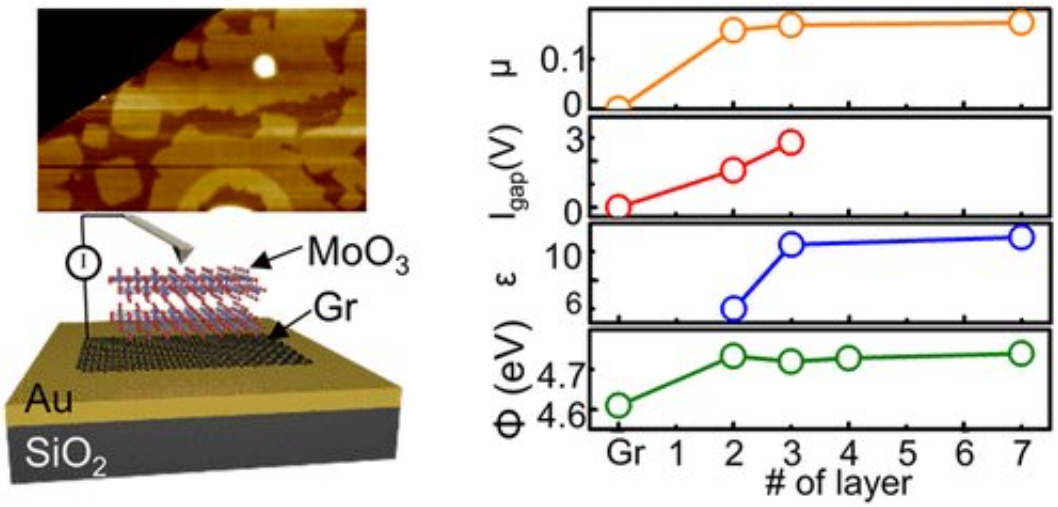
Epitaxially-grown molybdenum oxide advances as a bulk-like 2-D dielectric layer

November 13 2019



Credit: Seoul National University

Since the successful isolation of graphene from bulk graphite, remarkable properties of graphene have attracted many scientists to the brand-new research field of 2-D materials. However, despite excellent carrier mobility of graphene, direct application of graphene to field-effect transistors is severely hindered due to its gapless band structure. Alternatively, semiconducting transition metal dichalcogenides (TMDCs) have been focused intensively over the last decade. However, wide bandgap 2-D materials with > 3 eV have been required for UV-related optoelectronic devices, power electronics, and dielectric layers.

One of promising candidates is transition metal oxides (TMOs), which have a large bandgap, structural diversity, and tunable physical/chemical characteristics. Nevertheless, the scalable growth of atomically-thin TMOs remains challenging until now since it is very prone to lattice-mismatch strain and strong substrate clamping during growth.

Recently, the research team led by Prof. Gwan-Hyung Lee of Seoul National University overcame the issue by employing the van der Waals (vdW) epitaxial growth method. The research team reported a novel method for scalable growth of orthorhombic molybdenum oxide(α-MoO_3) nanosheets on the graphene substrate. An important question in this work is what the effect of thickness on the electrical and physical properties is. To figure out this, comprehensive atomic force microscopy (AFM) studies were performed to explore structural and electrical properties of MoO_3 layers with various thickness.

Interestingly, AFM study revealed that MoO_3 nanosheets retain bulk-like structural and electrical properties even when MoO_3 nanosheets are thicker than 2 - 3 layers (1.4 - 2.1 nm in thickness).

Particularly, the thickness-sensitivity of friction is very small compared to other hexagonal 2-D materials. This intriguing result is attributed to the doubled octahedral planes of monolayer MoO_3 with exceptionally small interatomic separation. Additionally, work function and dielectric constant are also thickness-independent, along with invariant electronic band structure regardless of the thickness. Besides, the team showed that MoO_3 nanosheets obtain a large current gap and high dielectric constant, emphasizing that MoO_3 can be used as promising 2-D dielectric materials.

More information: Jong Hun Kim et al, Thickness-Insensitive Properties of α-MoO3 Nanosheets by Weak Interlayer Coupling, *Nano Letters* (2019). DOI: 10.1021/acs.nanolett.9b03701

Provided by Seoul National University