Nanoscale electrical characterisation and nanomanipulation of MoO_{3-x} monolayer

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Two-dimensional van der Waals materials, such as dichalcogenides (MoS_2, WS_2, $MoSe_2$) and oxides (V_2O_5, WO_3, MoO_3), are a group of materials in which planar structures are held by strong in-plane covalent bonds and weak out-of-plane van der Waals forces. Their unique structure and properties allow for wide use in e. g. electronics, optoelectronics, catalysis, sensors, and data storage. Among this group of materials is orthorhombic molybdenum oxide α-MoO_3, which is transparent, has high relative permittivity, and a wide bandgap.

In this work, we present our research focused on nanoscale characterization. MoO_3 layers were deposited on highly orientated pyrolytic graphite (HOPG) by thermal evaporation under ultra-high vacuum conditions. Chemical composition studies show non-stoichiometry of the obtained monolayers - approximately 95% is represented by Mo^{6+} and 5% by Mo^{5+}. Studies conducted using atomic force microscopy indicate that point current stimulations enable precise nanomanipulation and nanolithography of molybdenum trioxide. In addition, the current maps confirm that slightly non-stoichiometric MoO_3 layers are non-homogeneous in terms of conductivity. Our research shows that when designing devices based on 2D transition-metal oxides, it is important to take into account the nanoscale heterogeneity of the material.

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