Tungsten Oxide Mediated Quasi - van der Waals Epitaxy of WS_2 on Sapphire

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Abstract
Today's state-of-the-art semiconductor technology relies heavily on conventional epitaxy for controlling thin films and nanostructures at the atomic level, which are the building blocks for nanoelectronics, optoelectronics, sensors, etc. Four decades ago, the terms “van der Waals” (vdW) and “quasi-vdW (Q-vdW) epitaxy”[1] were coined to explain the oriented growth of vdW layers on 2D and 3D substrates, respectively. In this study, WS_2 is grown by sequentially exposing metal and chalcogen precursors in a metal-organic chemical vapor deposition (MOCVD) system[2], introducing a metal-seeding stage before growth. The ability to control the delivery of the precursor made it possible to study the formation of a continuous and apparently ordered WO_3 mono-or few-layer at the surface of a c-plane sapphire. Such an interfacial layer is shown to strongly influence the subsequent quasi-vdW epitaxial growth on sapphire: This represents an important breakthrough in this field since a new epitaxial growth mechanism is elucidated[3]. A rational design of epitaxial growth on different materials systems may be enabled by this work.

References

[1] Koma, Journal of Crystal Growth, Issue 201-202, [pp. 236-241] (1999).
[2] Assael Cohen et al., ACS Nano, vol.15, no. 1, [pp. 526–538], (2021).
[3] Assael Cohen et al., ACS Nano, vol. 17 no. 6, [pp. 5399-5411], (2023).

Figures

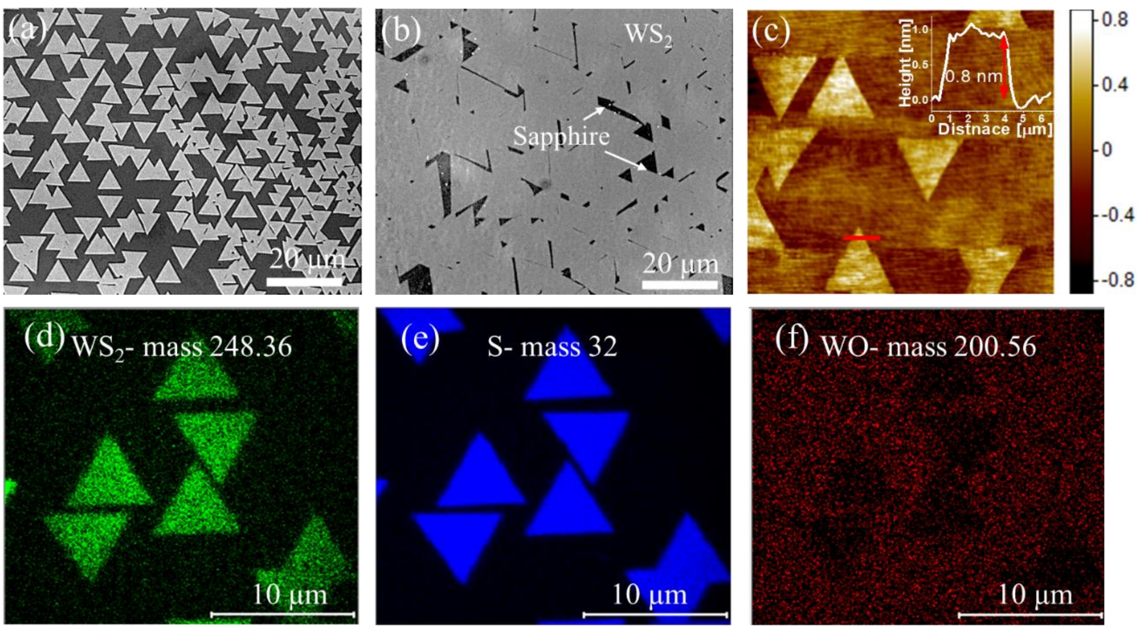

Figure 1: WS_2 epitaxial growth on sapphire (a-b)optical image; (c)AFM image;(d-f) TOF-SIMS analysis showing the domain and the WO_x interface layer between WS_2 to the sapphire.