

Rotational Commensuration in MoS₂ Epitaxy on Synthetic Mica for Electronic Devices

Luis Felipe Almeida¹

Dragana Tizic Matkovic², Simon Leitner¹, Thomas Pucher³, Andres Castellanos-Gomez³, Aleksandar Matkovic¹.

1) Chair of Physics, Department Physics, Mechanics and Electrical Engineering, Montanuniversität Leoben, Franz Josef Strasse 18, 8700 Leoben, Austria

2) Chair of Resource Mineralogy, Montanuniversität Leoben, Peter Tunner Strasse 5, 8700 Leoben, Austria

3) 2D Foundry Research Group, Instituto de Ciencia de Materiales de Madrid (ICMM-CSIC), Madrid E-28049, Spain

luis.almeida@unileoben.ac.at

Two-dimensional (2D) semiconductors have emerged as promising materials for next-generation electronic and optoelectronic devices due to their low dimensionality, strong electrostatic control, and tunable properties [1]. However, their performance is strongly influenced by the surrounding environment. When considering electrical device integration, the 2D semiconductor-to-gate-insulator interface is the primary issue. In this context, phyllosilicates have recently gained attention as layered dielectric substrates for 2D materials [2,3]. Their atomically flat surfaces and weak van der Waals interlayer bonding enable the formation of clean interfaces. In this work, we report the epitaxial growth of molybdenum disulfide MoS₂ on fluorophlogopite (FPh) substrates using an alkaline-hydroxide as the growth promoter (NaOH) in a chemical vapor deposition (CVD) process and investigate the resulting structural and electronic properties. Substrate-induced strain of $(0,6 \pm 0,2)\%$ is observed by Raman and photoluminescence spectroscopy. In addition, 2D Fast Fourier Transform (2D-FFT) analysis was performed of the observed growth patterns to obtain qualitative information on the rotational commensuration and crystallographic alignment between MoS₂ and the substrate, confirming the MoS₂/FPh rotational commensuration. For device integration, the MoS₂ layers were transferred using a water-assisted transfer method, enabling the fabrication of van der Waals field-effect transistors. The devices exhibit promising electrical performance, including enhanced carrier mobility and high on/off current ratios. These results demonstrate the potential of fluorophlogopite for epitaxial growth in TMD-based electronic devices.

References

- [1] Aslam, M. A. et al., Nano Lett. 24 (22) (2024) [6529–6537].
- [2] Barcelos, I. D. et al., J. Appl. Phys. 134 (9) (2023) [090902].
- [3] Xu, C. et al., Sci. Adv. 12 (2026) [eaeb6733].

Figures



Figure 1: (A) Optical image of MoS₂ grown on the FPh substrate. (B) AFM image of MoS₂ ribbons, demonstrating the jagged nature of the growth as well as the growth direction of the ribbons (red arrows). (C) Transfer curves of a transistor fabricated from a MoS₂ ribbon, using hBN as the dielectric (device optical image shown in the inset).