

Horizontal to Vertical Transition of MoS₂ grown by CVD on Mo studied by Spectroscopic Ellipsometry

Marín Patrito

Karen Navarro, Carlos Monzón, Juan De Paoli

Depto. Fisicoquímica, Fac. Ciencias Químicas, Univ. Nacional de Córdoba. Pabellón Argentina, 5000 Córdoba, Argentina

mpatrito@gmail.com

The control in the orientation of MoS₂ layers with respect to the growing substrate is of utmost importance in MoS₂ applications. Horizontally aligned MoS₂ layers are preferred for microelectronic devices, whereas vertically aligned MoS₂ layers are much useful for the hydrogen evolution reaction and energy storage. Fast sulfurization of metal-seeded substrates has been used to grow vertically standing MoS₂ nanosheets [1]. The layers grow until the thin Mo film (5-25 nm) is consumed. However, the growth of MoS₂ films on thicker Mo foils has not been investigated yet.

In this work we investigate structural transitions as a function of temperature for CVD grown MoS₂ on specular polished molybdenum surfaces exposed to sulphur gas. Figure 1a show that the thickness of the MoS₂ films obtained from the ellipsometric spectra (inset) have an abrupt transition around 800°C in agreement with the topography of SEM images which show a change from smooth films (Fig. 1b) to structures with vertically aligned layers (Fig. 1c).

The E_{12g} and the A_{1g} Raman modes (Fig. 2) were used to track the MoS₂ film growth as well as changes in crystallinity. The variation of peak areas with temperature (Fig. 2c) shows a different pattern as that of ellipsometric thicknesses (Fig. 1a). This is interpreted as due to changes in the density of the films associated to horizontal to vertical transitions. At the lower temperatures broader peaks are observed (Fig. 2a) and they become thinner as the temperature increases (Fig. 2b). The FWHM of the E_{12g} and the A_{1g} peaks shows a

continuous decrease with temperature (Fig. 2c) reaching the lowest value of 6.2 cm⁻¹ at 950 °C, thus indicating an increase in the crystallinity of the films.

References

- [1] D. Kong, H. Wang, J. J. Cha, M. Pasta, K. J. Koski, J. Yao and Y. Cui. *Nano Lett.* 13 (2013) 1341–1347

Figures

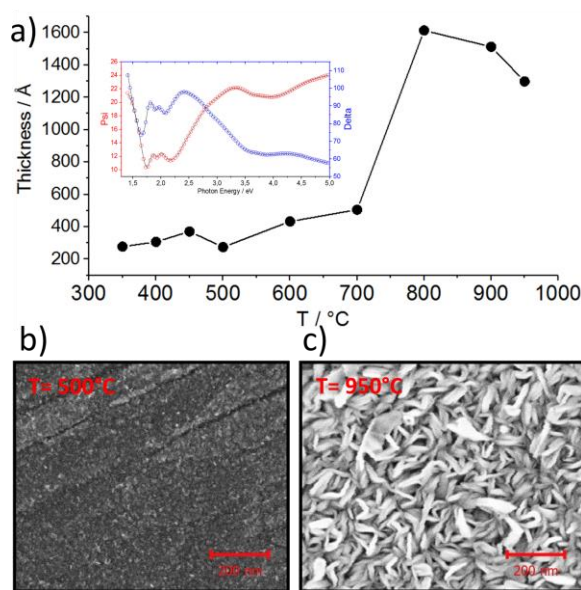


Figure 1: a) Ellipsometric thicknesses of MoS₂ films as a function of growing temperature. Inset: ellipsometric Δ-Ψ spectra and single layer model fit (solid line). SEM images of films grown at b) 500 °C and c) 950 °C.

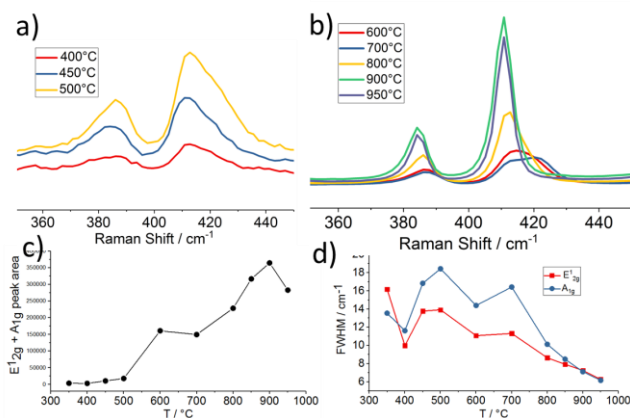


Figure 2: E_{12g} and the A_{1g} Raman peaks in a) 400 - 500 °C and b) 600 - 950 °C temperature range.

Temperature variation of **c)** peak area and **d)**
FWHM.
