MS24-2-3 3D scanning precession electron diffraction analysis of nanodomains in thin films
#MS24-2-3

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Abstract
Strain engineering is an efficient way to modify the ground state of epitaxial thin films in order to induce new features or improve existing properties. One of the challenges in this approach is to quantify structural changes occurring in these films. While X-ray diffraction is the most widely used technique to obtain accurate structural information on bulk materials, severe limitations appear in the case of epitaxial thin films due to the presence of a thick substrate (mm range) for a film thickness usually well below 100 nm.
This last decade, 3D electron diffraction (3D ED) [1], and notably precession electron diffraction tomography (PEDT), has shown its usefulness in the determination of new, metastable, phases stabilized in the form of thin films. While challenging, the determination of unknown structures does actually not represent the major need for thin films. In most cases, the deposited materials have a known structure. The question is not to solve the structure but to know how it differs from the bulk [2].
In this context, our aim is to develop a standard dataset acquisition technique in order to accurately quantify the structure of nano-sized domains in thin films. This can be done by combining the standard PEDT procedure with, for each tilt angle, a line or an area scan across the film section (Fig. 1). Known as scanning precession electron diffraction tomography (SPEDT) and already used for nanocrystalline microstructures analysis [3], this approach has the potential to become the standard procedure to characterize films as thin as 10 nm thanks to constant improvements in the illumination and detection systems of transmission electron microscopes. For thicker films, where strain relaxation might occur, line scan shall be sufficient to obtain structural information about the evolution of the structure versus thickness (Fig. 1a). Executed on an area of the film containing several domains (Fig. 1b), diffracted intensities related to each domain could be recorded and used for structure solution and refinement, increasing in this way the amount of information that can be obtained from a single acquisition.
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References
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Figure 1

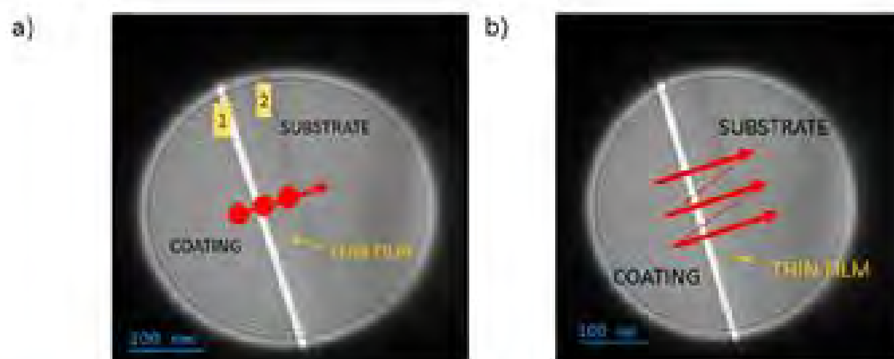

Figure 1: a) Scheme representing a line scan across the sample. The red arrow indicates the direction of the electron beam, while the red dots represent the electron beam at every step where a diffraction pattern is acquired. b) Scheme representing an area scan across the sample. In this case, the electron beam scanned on lines (red arrows) going from the coating to the substrate while acquiring the diffraction patterns.