A novel approach is proposed to evaluate chemical and structural gradients in polycrystalline thin film with a deca-nanometric resolution. Samples are measured in cross-section in transmission geometry using an X-ray nano-pencil beam. The high energy X-ray nano-beam is required and obtained by using only the vertical focus lenses of the ID11-ESRF beamline nano-focus set-up. Powder diffraction methods are therefore usable thanks to this strong asymmetric beam shape (inducing a large number of diffracting grains). Phase analysis with an in-depth resolution along the film thickness is first performed. For each phase, the 2D diffraction pattern is used to determine micro-structural gradients such as strain, stress, texture and grain size. Fluorescence spectra, absorption profile recorded from other detectors (Energy Dispersive detector and diodes) are also used together to strengthen analysis.

In-depth resolution, technique accuracy and limitations (alignment, calibration) are discussed. This will be illustrated by several examples on functional thin films (polycrystalline PZT, oxidized Fe) which have been advantageously characterized by this kind of experiment.

Fig.: (a) Nano-line diffraction set-up on ID11@ESRF (b) Phase profile analysis in an oxidized Fe polycrystalline thin film and (c) Stress profile (150 nm in depth resolution)


**Keywords:** Nano-diffraction, Gradient, Strain, Texture, Polycrystal