18/02/2026

The ESRF, the European Synchrotron, an international research facility based in Grenoble, is currently seeking to have a:

Trainee in Deep-learning for thin film deposition
for a 3 to 6-month Internship

INTERNSHIP DESCRIPTION

Within the X-ray Optics Group, Instrumentation and service development division (ISDD) and under the supervision of Patrice Bras, Thin-film deposition engineer, you will be working on the following topic.

Modern synchrotron beamlines require optical elements with extremely well-defined surface shapes and roughness values in the order of an angstrom (10^{-10} m) to preserve the high quality of the incident x-ray beam. Several advanced polishing techniques can be applied to enhance the surface properties of x-ray optical elements but they typically induce residual height errors in the order of a few nanometres. These can be corrected by spatially resolved material erosion (for instance ion beam figuring) in so-called subtractive correction methods. Alternatively, additive strategies can be implemented. The latter approach is pursued at the ESRF through the application of differential deposition. The process relies on the deposition of a corrective layer, with locally controlled thickness, over the optical element to improve its surface shape (Figure 1).

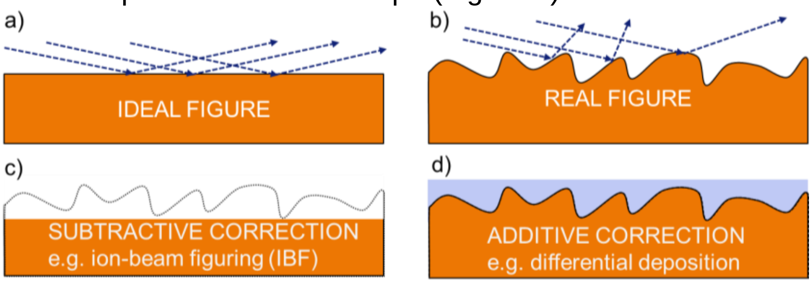

Figure 1. a) Ideal flat and smooth surface. b) Real figure with defects voluntarily emphasized. c) Subtractive correction method where material is locally eroded. d) Additive correction method where a film of varying thickness is applied

The process of differential deposition relies on the controlled motion of the sample-to-be-corrected in front of a static particle flux cropped by a thin vertical slit (Figure 2). By varying the speed at which the sample moves, the local thickness of the deposited film can be adjusted. Material deposition is carried out using magnetron sputtering.

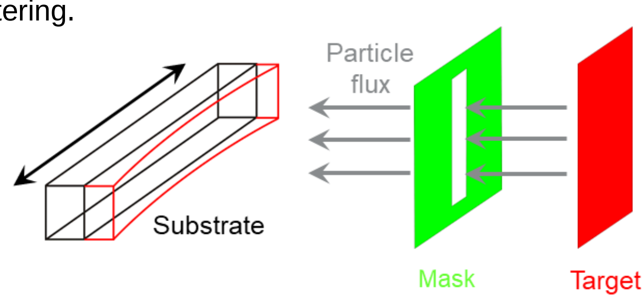

Figure 2. Principle of differential deposition using sputtering. A particle flux is emitted from the sputtering target (red), through the mask (green), and builds up a film on the moving substrate (black)

Differential deposition for figure error correction is already successfully applied at the ESRF, resulting in final height errors below 1nm RMS [Bras, P., Morawe, C., Laboure, S., Perrin, F., Vivo, A. & Barrett, R. (2023). J. Synchrotron Rad. 30, 708-716.].
The current process, so-called 1D differential deposition, takes the height profile along a centered line on the sample as a reference, resulting in very high correction quality along this line. Although height

errors are also reduced further from the central profile, the correction quality could be improved by expanding the process to two dimensions (Figure 3).

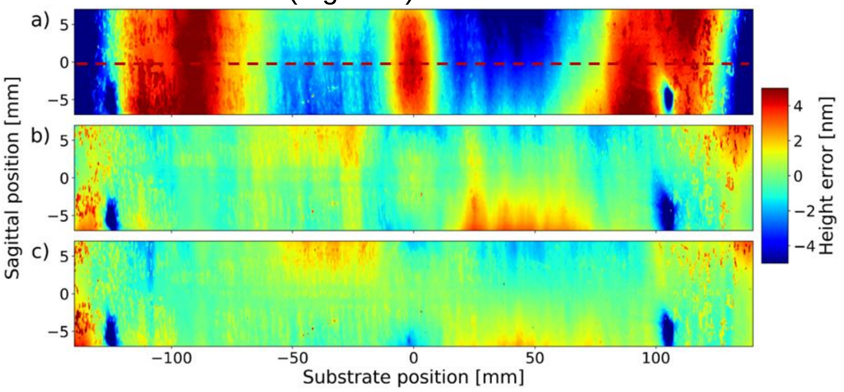

Figure 3. Height error map measured on the same sample before correction (a), at an intermediate stage in the correction process (b), after the final correction by 1D differential deposition (c). The correction reference line is shown in red.

Standard 1D routines used for differential deposition calculations are difficult to apply in 2D and may not even be possible in some cases.

The application of artificial intelligence, and more precisely neural networks, is believed to bring additional solutions in this context. The objective of this project is to develop a neural network to predict relevant process parameters (substrate speed profile during deposition, slit shape to be used) to successfully perform differential deposition in 2 dimensions.

The core task will be the elaboration and testing of the neural network architecture (inputs, outputs, number and type of layers…). The neural network model will be coded in Python using the dedicated PyTorch library. Another important topic will be the generation of relevant training data for the model through simulation using already available and to-be-developed software tools. Once a satisfactory model is obtained, practical deposition tests based on parameters predicted by the neural network could be performed, if time allows.

PROFILE, SKILLS

- You are a student in M1 or M2 (or second/third year of engineering school) in Physics, Material science, Applied mathematics, Data science…
- You have some experience of artificial intelligence and particularly deep-learning
- You know Python and the scientific/deep-learning libraries, mainly Numpy, Scipy, Pandas and Pytorch.
- Ideally, you have some knowledge about thin film deposition processes although it is not absolutely necessary
- You are curious and autonomous
- You have good oral and written communication skills in English.

STARTING DATE

As soon as possible.

If you are interested in this position, please send your CV and cover letter to: patrice.bras@esrf.fr / morawe@esrf.fr / traineeship@esrf.fr