

EXPERIMENT MA-5204

Investigation on the crystallization kinetics of amorphous Ta₂O₅ thin films for interferometric gravitational wave detectors

This experiment follows the HC2315 and HC1185 experiments that we carried out at ESRF, aimed to investigate the local structure of pure and doped amorphous *a*-Ta₂O₅. The results of these experiments are published in Ref. [1].

The aim of the experiment was to study the local and medium range structure of amorphous *a*-Ta₂O₅ by means of a total scattering experiment with high energy X-rays. In particular, we aimed to investigate the evolution of the structure of *a*-Ta₂O₅ thin films submitted to a thermal treatment by time-resolved, pair distribution function (PDF) analysis. At this scope, we probed the structural rearrangements occurring when *a*-Ta₂O₅ starts to crystallize, in order to identify the resulting polymorphic structure and determine the kinetics of the transformation process.

The experiment was carried out at the ID11 Beamline of ESRF. Data were collected by orientating the amorphous *a*-Ta₂O₅ thin film (maximum 100-nm-thick) parallel to the X-ray beam (< 1mm along the longitudinal size; see Figs. 1 and 2). In this way the contribution of the Si single crystal substrates does not affect the experimental data.

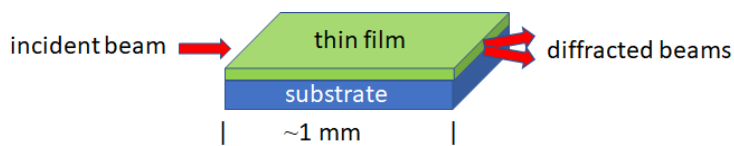


Figure 1: Experimental set-up adopted for collecting total scattering X-ray data.

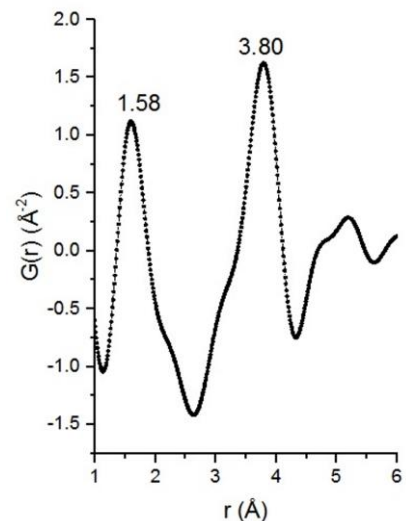


Figure 2: PDF of *a*-Ta₂O₅ obtained using the experimental set-up of Fig. 1; no contribution of the Si substrate can be detected

In-situ acquisition of pair distribution function data from α -Ta₂O₅ at different time steps during isothermal treatment was carried out and thermal treatments in air with different maximum temperatures (700°C; 725°C, 750°C, 775°C and 800 °C) were tested.

Preliminary data shows a clear evolution of the PDF patterns as a function of time and temperature, evidencing a rearrangements of the local structure of α -Ta₂O₅.

References

[1] A. Martinelli, M. Giovannini, M. Neri, G.Gemme, Deep insights into the local structure of amorphous Ta₂O₅ thin films by x-ray pair distribution function analysis, *Physical Review Materials* **5** (2021) 115603