Residual stress and texture analysis in thin films using GIWAXS geometry employing a focused X-ray beam

G. Newby[1], A. Tutueanu[1], N. Vaxelaire[2], E. Le Cun[2], G. Freychet[2], P. Gergaud[2], P. Panine[1]

[1] Xenocs SAS, 1-3 Allée du Nanomètre, 38000 Grenoble, France

[2] Univ. Grenoble Alpes, CEA, Leti, F-38000 Grenoble, France

In-line metrology plays a critical role in ensuring the quality and reliability of microelectronic and semiconductor products, enabling manufacturers to maintain high levels of productivity, efficiency, and competitiveness in the industry. This imposes specific constrains on the techniques employed that need to be able to perform non-destructive, rapid and reliable measurements. Thin films in particular, typically ranging from a few nanometers to a few tens of nanometers in thickness, play a critical role in various device fabrication processes. Performing measurements on polycrystalline thin films presents unique challenges and requirements for in-line metrology equipment.

In this study, we present residual stress analysis and texture measurements obtained on thin film samples with interchangeable focusing X-ray source (AuX source) of the Xeuss 3.0 (GI-)SAXS/WAXS/USAXS laboratory beamline.

Firstly, we demonstrate the capability of performing fast residual stress measurements using an auxiliary focusing source and 2D detection on a polycrystalline $Ge_2Sb_2Te_5$ (GST225) thin film. A comparison with measurements acquired on a 4-circle goniometer confirmed the accuracy of the results with a significant gain of measuring time and access to several crystallographic reflections within a single data set making it highly relevant for in-situ measurements as well.

Secondly, we showcase the advantages of using an auxiliary focusing source for texture measurements by analysing a PtSi sample exhibiting a well-oriented crystallographic domain. A significant increase of peak intensity compared to regular collimated geometry all together with the preservation of the angular resolution is demonstrated. This enables the performance of complete texture measurements in a reduced experimental time.

Finally, we will present recent grazing incidence X-ray scattering experiments demonstrating the sensitivity of the surface measurement technique in the lab for very thin samples.