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► **To cite this version:**

J P Zhang, C Pendenque, K Le Guen, R Delaunay, I Vickridge, et al.. Kossel interferences of proton-induced X-ray emission lines to study the interfaces of thin film waveguides. PXRNMS2018, Physics of X-ray and Neutron Multilayer Structures, Nov 2018, Palaiseau, France. hal-03932389

HAL Id: hal-03932389

<https://hal.science/hal-03932389v1>

Submitted on 10 Jan 2023

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Kossel interferences of proton-induced X-ray emission lines to study the interfaces of thin film waveguides

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While waveguide optic is ubiquitous in the visible and infrared spectral range, it is still much less developed in the X-ray regime. X-ray waveguides can be used as spatial and coherence filters for X-ray coherent imaging. They are usually designed and fabricated with a low density guiding layer embedded in high density cladding layers. The interfaces of the thin film waveguides play a crucial role in their service reliabilities. In this study, Pt/Fe/Pt and Ta/Cr/Pt thin film waveguides are firstly designed by using the IMD software, and then deposited on Si substrates by magnetron sputtering. Grazing incident x-ray reflectometry is performed to obtain the geometrical information of the designed thin films waveguides. The Kossel interference of proton-induced X-ray emission lines (PIXE) [1], as a non-destructive way, is used to analyze the interfaces of the thin films, as shown in Fig.1. PIXE is an X-ray spectrographic technique, which can measure the characteristic radiations emitted by electron transitions and identify each element. It is used in Kossel geometry to obtain what we call Kossel curves, i.e. the angular distributions of the intensity of the characteristics emissions. In our experimental conditions, we use an energy dispersive CCD camera, which enables performing the experiment without any rotation of the sample or camera. By comparing the experimentally obtained Kossel curves of the characteristic emissions and the simulated ones, the interfacial environments of the studied stacks can be explained.

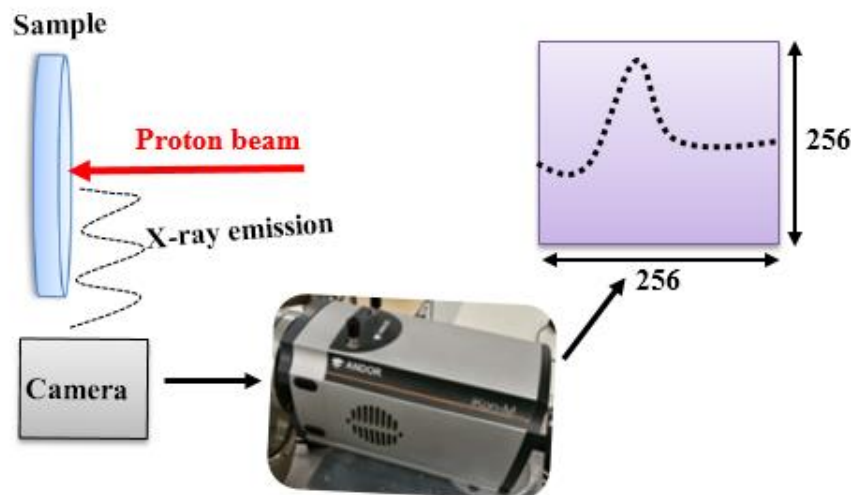


Fig. 1. Experimental setup of the PIXE-Kossel experiment. A column of pixels of the CCD camera measures the emitted intensity at one angle. The 256 columns enables scanning a 3° angular range without moving any part of the experiment.

References

[1] M.-Y. Wu et al., NIM B386 (2016): 39-43.