Kossel diffraction observed with an x-ray color camera during PIXE of multilayers with nanometric period

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Excitation with protons of a periodic stack of alternating high and low indices results in emission of characteristic x-rays from within the stack, that present significant interference effects when observed in the vicinity of the Bragg angle corresponding to the characteristic X-ray wavelength and multilayer stack period. This is termed Kossel diffraction. Simulations show that the angular distribution of the characteristic X-rays in the vicinity of the Bragg angle is very sensitive to the stacking order and to interface diffusion and roughness, due to the precise positioning of the corresponding X-ray standing wave within the multilayer stack. We have previously presented a proof-of-principle experiment in which we give the first observations of PIXE Kossel diffraction from a practically ideal multilayer stack, using a Cr/B_4C/Sc of period 1.72 nm [1]. In that work, a highly collimated Peltier cooled Rontec X-ray detector at fixed angle was used whilst the multilayer was oriented with a channelling goniometer, resulting in very long measurements with limited angular resolution and counting statistics. In the present work, we present PIXE Kossel interference curves obtained with an X-ray camera, with much improved angular resolution and counting statistics, from a series of multilayer stacks of nanometric period with various stacking orders and interface structures, showing that PIXE Kossel measurements can be a reliable alternative to X-ray Standing Wave methods for characterisation of nanometric periodic multilayer structures.

[1] Wu M., Le Guen K., André J.-M., Ilakovac V., Vickridge I., Schmaus D., Briand E., Steydli S., Burcklen C., Bridou F., Meltchakov E., De Rossi S., Delmotte F., Jonnard P. (2016). *Kossel interferences of proton-induced X-ray emission lines in periodic multilayers*. *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*, 386(1):39-43. doi: https://doi.org/10.1016/j.nimb.2016.09.014.