Kossel X-ray standing-waves within a Cr/B₄C/Sc multilayer excited by protons

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A characteristic X-ray line emitted from an atom within a periodic structure can be diffracted by the (emitting) structure itself according to the Bragg law. The subsequent Kossel interferences lead to a modulation of the x-ray line intensity as a function of the detection angle in the vicinity of the Bragg angle value [2]. Standing-wave mechanism and Kossel diffraction can be viewed as space reversed processes by virtue of the reciprocity theorem. Kossel interferences have been yet observed using incident X-ray radiation [3-4], electrons [1-2, 5] and ions [6], in crystals [2,5-6] and in periodic multilayers [2-4].

In the present work, we have studied the characteristic Cr and Sc Kα emissions produced by a periodic Cr/B₄C/Sc multilayer exposed to a beam of 2 MeV-protons. The period of the multilayer is close to 2 nm. The intensity of these two emission lines is measured as function of the grazing exit angle, i.e. the angle between the direction of the detector and that of the surface of the multilayer. In the case of the Sc Kα emission, in Figure 1 we compare the experimental results to those calculated combining a classical recursive approach to the reciprocity theorem. To our knowledge, it is the first time that ions are used to induce Kossel diffraction in a multilayer. Refined details about the structure of the stack could be obtained, especially the profile and nature of the interfaces.

![Figure 1: Measured (red) and calculated (blue) intensity of the Sc Kα emission as a function of the detection angle.](image)