

# High resolution sliced multilayer grating for soft x-rays

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Resonant Inelastic X-ray Scattering (RIXS) with soft x-rays is one of the most effective techniques for investigation of the electronic structure of materials, specifically, excitations in correlated electron systems. However the potential of the RIXS is limited by low spectral resolution of existing grating spectrometers. To achieve the  $\sim 1$  meV energy resolution at x-ray energies of 500 eV – 1.3 keV required to access relevant core levels, ultra-high resolution grating optics have to be developed.

We describe a new technique for fabrication of EUV and soft x-rays multilayer gratings with extremely high groove density, up to  $\sim 50,000$  1/mm. Such a grating with total length of  $\sim 20$  mm would provide a spectral resolution of as high as  $10^5$ - $10^6$ . The technique consists of deposition of a high reflectivity multilayer on an echelette-like substrate followed by surface polishing performed at small angle in order to obtain a large sliced multilayer grating (Fig. 1).

High potential efficiency of such a grating, optimized for 1 keV, has been demonstrated via numerical simulation.<sup>1</sup> In this work we discuss the results of optimization of the echellette production. The echellette substrates are fabricated by anisotropic etching of Si single crystals with aqueous KOH. A 6 degree blaze angle of the grating is provided by a proper slice angle of the crystal surface with respect to the (111) planes. The morphology of (111) etched facets is studied with a scanning probe microscope. The parameters of the fabrication process are optimized by minimizing distortion of the echellette figure and finish.

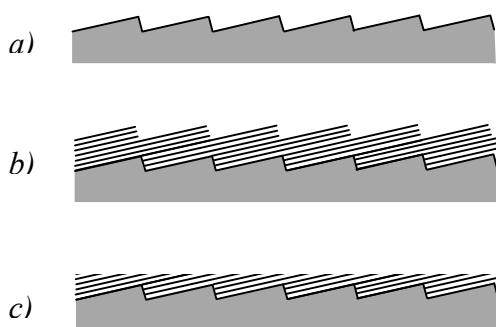


Figure 1: Fabrication of a high resolution diffraction grating:

a) fabrication of an echelette-like substrate;

b) deposition of a soft X-ray multilayer;

c) fabrication of an ultra-high dense grating by polishing of the multilayer surface.

<sup>1</sup> D. L. Voronov, R. Cambie, R. M. Feshchenko, E. M. Gullikson, H. A. Padmore, A. V. Vinogradov, and V. V. Yashchuk, "Development of an ultrahigh-resolution diffraction grating for soft x-rays," *Proc. SPIE* 6705, 67050E (2007).