Soft X-Ray Critical-Angle Transmission Grating Spectrometer for the International X-Ray Observatory

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ABSTRACT: We have developed a new type of soft x-ray diffraction grating. This critical-angle transmission (CAT) grating [1-4] combines the advantages of traditional transmission gratings (very low mass, extremely relaxed alignment and flatness tolerances) with those of x-ray reflection gratings (high efficiency due to blazing in the direction of grazing-incidence reflection). In addition, grating spectrometers based on CAT gratings are well-suited to co-existence with high-energy focal plane microcalorimeter detectors as planned for the International X-Ray Observatory, since most high-energy x-rays are undeflected and arrive at the telescope focus. We have previously micro-fabricated 574 and 200 nm period prototypes of the smooth, high-aspect ratio, and sub-micron period structures necessary for efficient CAT gratings through interference lithography, anisotropic etching of silicon crystals, and critical-point drying. X-ray test have demonstrated high efficiency blazing in accordance with theoretical predictions. We will describe the CAT grating principle and design, fabrication, and x-ray efficiency measurements, and discuss various high-resolution (E/ΔE ~ 5000), high-effective area (up to 10,000 cm²) implementations for a CAT grating spectrometer.