Development of Fabrication Process for Critical-Angle X-ray Transmission Gratings

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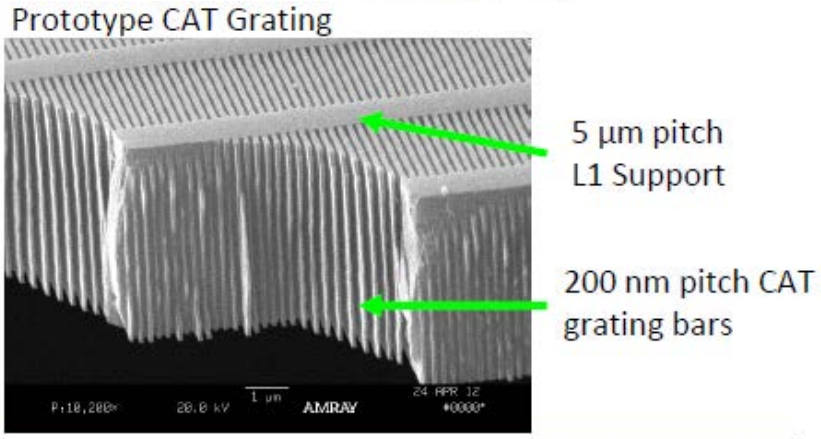
Objectives and Key Challenges:

- Develop key technology to enable a Critical-Angle X-ray Transmission Grating Spectrometer (CATGS), advancing to TRL-6 in preparation for proposed missions or Explorers over the next two decades
- Develop improved grating fabrication processes and procure advanced etching tool and other infrastructure in order to accelerate technology development

Significance of Work:

- Development of nanofabrication technology for the silicon nanomirror grating elements
- Development of microfabrication processes for the integrated grating support mesh



Approach:

- Integrated wafer front/back-side fabrication process using silicon-on-insulator (SOI) wafers
- Wafer front side: CAT grating structure + Level 1 support
- Wafer back side: Level 2 support hex-mesh structure
- CAT grating fabricated by deep reactive ion-etching (DRIE) followed by KOH polishing
- Bonded to expansion-matched metal support frame (Level 3 support)
- X-ray testing of prototypes at synchrotrons and MSFC facility

Key Collaborators:

- William Zhang (GSFC)
- Steve O'Dell (MSFC)

Current Funded Period of Performance:

- FY12-FY14

Recent Accomplishments and Next Milestones:

- Developed improved DRIE process with significantly reduced line bowing. Developed improved backside etch process.
- Demonstrated KOH polish to full 4.0 µm depth following DRIE.
- Demonstrated fully-integrated 31x31 mm^2 grating with KOH polish.
- Developed novel process to produce stress-controlled SOI wafers.
- Acquired and installed new DRIE tool (SPTS Pegasus) in SNL.
- Transferred process to new tool and demonstrated excellent etch profile control.
- Fabricated CAT gratings with record soft x-ray diffraction efficiency.

Application:

- Flagship, Probe and Explorer class x-ray astronomy missions requiring high resolution spectroscopy
- Laboratory x-ray analysis (materials science, energy research)

TRLin = 3 ***TRLcurrent = 3*** ***TRLtarget = 6***