Advanced Packaging for Critical-Angle X-ray Transmission Gratings

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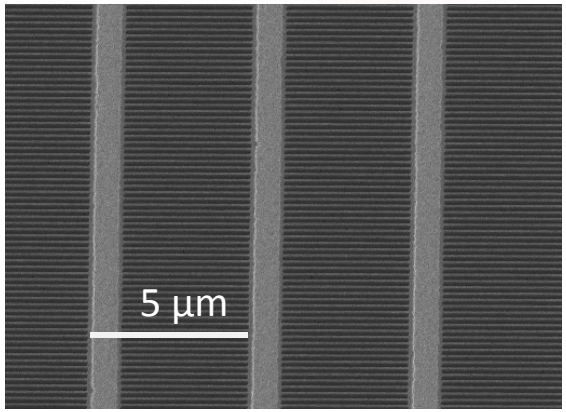
Objectives and Key Challenges:

- Develop key technology to enable a Critical-Angle X-ray Transmission Grating Spectrometer (CATGS), advancing to TRL 6 in preparation for proposed mid- and large-size missions over the next decade
- Develop improved grating fabrication processes
- Develop frame mounting, alignment, and assembly techniques for CAT grating arrays

Significance of Work:

- Improved diffraction efficiency and resolving power for CATGS
- Ability to manufacture large-area, light-weight grating arrays



Scanning Electron Micrograph (SEM) of a free-standing CAT grating after DRIE and KOH polish.

Approach:

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

Key Collaborators:

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

Current Funded Period of Performance:

- FY15-FY16

Recent Accomplishments:

- Optimized combined dry- and wet-etch processes to obtain smooth grating bar sidewalls and narrow L1 supports and produced free-standing large-area gratings with hierarchy of low-blockage supports
- Achieved record absolute x-ray diffraction efficiency (> 30%)

Next Milestones:

- Demonstrate CAT grating resolving power in an x-ray imaging system to achieve TRL 4 (Jan/Feb 2016)
- Demonstrate aligned gratings with prototype frame assembly to achieve TRL 5 (October 2016)

Application:

- Flagship x-ray missions
- Explorer x-ray missions
- Laboratory x-ray analysis (materials science, energy research)

TRLin = 3 ***TRLcurrent est. by PI = 3*** ***TRLtarget = 6***