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Multilayer Etched Antireflective Structures for Silicon Vacuum Windows

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Future instruments employing cryogenic detectors for millimeter and submillimeter astronomy applications can benefit greatly from silicon vacuum windows with broadband antireflection treatment. Silicon is an ideal optical material at these wavelengths due to numerous attractive properties, including low loss, high refractive index, and high strength. However, its high index ($n = 3.4$) necessitates antireflection (AR) treatment, which has proven a major challenge, especially for the multilayer treatments required for wide spectral bandwidths. We address this challenge by developing a wide-bandwidth integral AR structure for silicon vacuum windows using a novel fabrication technique, tuning the effective refractive index of each AR layer using deep reactive ion etching (DRIE) and using wafer bonding to assemble the structure.
We present the progress we have made in designing and fabricating such vacuum windows from 100 mm-diameter silicon wafers. We have previously demonstrated a 2-layer AR structure for windows over a 1.6:1 bandwidth and are currently fabricating a 4-layer coating designed for a 4:1 bandwidth. We have also converged on a design for a 6-layer structure optimized to give -20 dB reflection between 80 and 420 GHz (5.25:1 bandwidth), which will be useful for future multicolor Sunyaev-Zel'dovich (SZ) observations.

Less than 5 years of experience since completion of Ph.D

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Student (Ph.D., M.Sc. or B.Sc.)

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