HIGH CONTRAST IMAGING WITH POLYCAPILLARY OPTICS

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Polycapillary x-ray optics provide an innovative new way to control x-ray beams. Placing these optics after the object to be imaged provides very efficient rejection of Compton scatter, while allowing image magnification without loss of resolution, image demagnification, or image shaping to match with digital detectors. An extensive study of the effects of surface and profile defects have greatly enhanced the understanding of the manufacturing process and lead to improved reproducibility and manufacturability of the optics. Measurements were performed on magnifying tapers. The optics had measured primary transmissions greater than 50% and scatter transmission of less than 1%. For a 5-cm thick Lucite phantom, this resulted in a contrast enhancement compared to a conventional grid of nearly a factor of two. The magnification from the tapered capillary optics improved the MTF at all frequencies out to 1.9 times the original system resolution. Increases below the system resolution are most important because clinically relevant structures generally occupy lower spatial frequencies.

Alternatively, placing a collimating optic and diffracting crystal before the patient provides sufficient monochromatic beam intensity for medical imaging. Contrast, resolution, and intensity measurements were performed with both high and low angular acceptance crystals. At 8 keV, contrast enhancement was a factor of 5 relative to the polychromatic case, in good agreement with theoretical values. At 17.5 keV, monochromatic subject contrast was more than a factor of 2 times greater than the conventional polychromatic contrast. An additional factor of two increase in contrast is expected from the removal of scatter obtained from using the air gap which is allowable from the parallel beam. The measured angular resolution after the crystal was 0.6 mrad for a silicon crystal. The use of polycapillary collimating optics allowed monochromatic imaging measurements using a conventional rotating anode source and computed radiography plate in 300 mAs.