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A Micromanufactured Diode Beamstop

Many experimental techniques utilize highly concentrated beams of x-rays directed at samples of materials of different types. When x-rays interact with these samples, a portion of them are deflected by the sample materials. These deflected x-rays then travel to a detector, and experimenters use the patterns of deflected x-rays captured by the detector to obtain information about the experimental samples. However, much of the x-ray beam passes through the experimental samples without interacting with them. This portion of the x-ray beam also travels toward the detector. If this were allowed to interact with the detector, it would overwhelm (and slowly damage) the detector, and the interaction from the x-rays and the sample could not be observed. In order to prevent this, a beamstop is placed between the sample and the detector to capture the non-deflected x-rays. In order to be fully effective and useful, a beamstop should be as small as possible to prevent obstruction of the deflected x-rays from the sample but dense enough to completely absorb the non-deflected x-rays.

The non-deflected x-rays (also known as direct beam) carry information about the intensity, size, and position of the x-ray beam that would be valuable to experimenters if it could be captured and characterized in real time during an experiment. Attempts by others to build beam characterization instrumentation directly into a beamstop have met with little success; generally the resulting device has been larger than the ideal or produced unacceptable scattering that affected the primary experiment. Our integrated beamstop and intensity measurement device (the DBS) overcomes these limitations in a completely novel, highly compact form. The core principles of the DBS are applicable to a wide range of miniature, non-invasive, real-time x-ray sensing and dose control applications.

Micromachining and assembly techniques have been used to produce the DBS. The DBS allows direct beam to be measured continuously in real time with sub-millisecond time resolution. The active portion of the assembly is very compact, and measures less than 1mm in diameter. The passive portion of the assembly is 1.25 mm in diameter, and could be made even smaller. The incorporation of active beam intensity measurement capability does not compromise the beamstop attenuation characteristics in any way, and images remain free of beamstop scatter or bleedthrough at integrated doses well in excess of 10^13 photons.

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