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# Characterization of SiC free-standing membrane for X-rays intensity monitor in synchrotron radiation beamlines

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Experiments with synchrotron radiation demand precise monitoring of X-ray beams, often accomplished with $I_0$-detectors like ion chambers or thin photodiodes. While diamond is known for its minimal absorption in transmission X-ray detectors, silicon carbide (SiC) is emerging as a promising alternative due to recent advancements in fabrication. Precise determination of parameters, such as, responsivity and transmittance is essential for calculating incident and transmitted photon fluxes, offering insights into the functionality of final detector monitoring. This research focuses on an in-line intensity monitor for tender and hard X-rays, employing a "free-standing membrane" device created by SenSiC GmbH, comprising three SiC layers: 0.3 µm $p^+$-doped, 1.5 µm $n^-$-doped, and 370 µm $n^+$-doped. The 4x9 $mm^2$ device is subjected to selective electrochemical etching to create a 3 mm diameter circular window in the $n^+$-doped layer for beam detection. Experimental studies were carried out at the four-crystal monochromator (FCM) beamline of PTB, within the BESSY II synchrotron radiation facility in Berlin. Based on the measurements, calculations were performed for X-ray absorption, electron-hole generation, and carrier diffusion into the bulk layer. The signal generation in both the membrane and bulk regions was investigated, resulting in a charge collection efficiency (CCE) of at least 85% for the device. The membrane's transmission was tested across the range of 1.75 to 10 keV and compared with absorption cross-sections from Henke et al. Transmission and current distribution maps were obtained through raster scans using 8 keV X-rays, indicating excellent surface uniformity of the membrane and a high transmission coefficient (0.9755, with a standard deviation of 0.0005). At a photon flux of $1.95 \times 10^8$ $s^{-1}$, the average photocurrent is 0.586 nA with a uniformity of 0.02 nA, while in the bulk region, the signal increases to 1.14 nA due to minority carrier diffusion.

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