Diamond Radiation Detectors—from photon to proton

ABSTRACT:

Diamond is well known for its extraordinary properties such as radiation hardness, thermal and electrical properties, which makes it an ideal material for radiation detection. My research focuses on diamond radiation detectors, developed mainly for applications at X-ray synchrotrons, to monitor X-ray beam flux, position, shape and pulse structures. Also, the low absorption of carbon in hard X-rays makes them feasible to work as transmission-mode detectors for real-time monitoring. Ultra-nanocrystalline diamond (UNCD) is employed as a new type of electrode material to replace metal electrodes, making the detectors “all-diamond” and eliminating extra X-ray absorption edges. Diamond radiation detectors are also considered as promising detectors for particle sources such as proton beams and carbon ion beams. We have tested the lifetime of our detectors using 800MeV proton beam at LANL and characterized the detector behavior after irradiation. A non-constant distribution of radiation damage was observed in diamond crystals along the proton beam path, affecting the carrier transport for detector performance. This phenomenon was confirmed by simulation results from FLUKA, in which the distribution of atom displacement corresponds well to experimental results. We also measured proton beam flux rate and line profile, confirming the possibility of diamond detectors for proton beam diagnostics.