Silicon Drift Detectors with Graphenic Carbon Windows

Abstract:
Silicon Drift Detectors (SDDs) are mainly used for x-ray fluorescence analysis and energy dispersive spectroscopy (EDS). Reliable operations of SDDs require hermetically tight housings with integrated, highly transparent x-ray windows. Vacuum encapsulation allows for efficient detector cooling but the resulting pressure load of 1 bar weighs on the x-ray windows, which is a mechanical burden for the window material. Standard transmission windows are made out of beryllium due to its high x-ray transparency and mechanical strength. Beryllium windows do not require a support structure. However, their thickness of at least 8 μm absorbs low energy x-rays below 1 keV. Therefore, light element detection in EDS applications is not possible with Be transmission windows. As beryllium is toxic, its production requires extensive precautions and broken windows contaminate the surroundings. Low energy transmission windows need to be extremely thin, which seems contradictory to the high mechanical stability. Polymer windows are commonly chosen as low energy windows and achieve an acceptable x-ray transmission for radiation in the energy range below 1 keV by using low Z elements and a reduced window.
thickness. However, the low temperature tolerance of polymer windows impedes vacuum encapsulation and thus limits the detector performance. The low stability of the polymer films requires a support grid and leads to a fill factor below 80%. As a replacement for both, Be and polymer windows, Graphenic carbon windows have been designed and fabricated by KETEK. They show a superior transmission compared to conventional windows and allow for vacuum encapsulated detector modules. The high mechanical resilience of Graphenic carbon is demonstrated by pressure cycle tests, yielding over 10 million cycles without damage. Qualification test results of the Graphenic carbon windows are presented. Long term stability and reliability data of the new windows are shown.

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