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Preliminary studies on GEM foil degradation in harsh radiation environments

Several High Energy Physics experiments are adopting Gaseous Electron Multipliers (GEMs) in substitution for the Multi-Wire Proportional Counters (MWPC) either in upgrade plans or in the design stage. The ALICE experiment, for instance, is passing through upgrades that, among other goals, aim the replacement of the MWPC at the readout planes of its Time Projection Chamber (TPC) by a stack of four GEMs. By this replacement, achieving a higher count rate capability and no need for the gate mode of operation are the ultimate goals. The count rate enhancement of the TPC together with the Inner Tracking System (ITS) upgrade shall increase the ALICE efficiency for particle identification drastically. Another example is the upgrade of the CMS experiment where GEM are replacing the MWPC at the Muon chamber end caps. Improvements in the maximum limit of count rate and in the Higher Level Trigger are expected by adopting a stack of three GEM-foils. Because of all this interest on GEMs for high count rates measurements, it is important to evaluate the degradation of its constituent materials under such circumstances. This work aims to bring insights from material science to that matter. For this, we studied two possible effects that may play some role in the degradation process of the GEM foils in a harsh radiation environment: One of them is the Kapton degradation due to energy deposition by ionization, which is an effect expected to be triggered by highly energetic particles. We degraded a Kapton foil using 2.2 MeV He+ ions. At this energy, the electronic stopping dominates the interaction processes, thus depositing energy by sequences of ionization. The Kapton composition was assessed by real-time nuclear scattering spectrometry, revealing the Hydrogen losses as the major effect. The second process considered in this study is the erosion of the Copper clad. Opposite to the Kapton degradation, the Copper clad erosion is expected to be induced by low energy ions associated with a sputtering process of the Copper. These low energy ions are expected to be generated during the avalanche of ionization in the amplification process. This effect was explored by computer simulation using the Garfield++ library and estimates of sputtering yields.

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