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Effects of hydrocarbon admixtures to the electroluminescence yield of He-CF4

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He-CF_4 is a very attractive gas mixture for Electroluminescence (EL)-based tracking detectors, with applications in Optical Readout Time Projection Chambers for Dark Matter Search. Whereas He maintains a low target mass (relevant for track reconstruction and low WIMP mass sensitivity), CF_4 is a fast and efficient scintillator in the UV and visible wavelengths, also providing sensitivity to spin-dependent WIMP-nucleon interactions due to its high fluorine content.
The addition of hydrocarbons to He-CF_4 increases the H content of the mixture, improving the tracking capabilities and low WIMP mass sensitivity. Nevertheless, hydrocarbons are known to quench the EL photons produced by some scintillating species, reducing the signal amplification through EL. Therefore, it is necessary to find the optimum hydrocarbon admixture to He-CF_4 (species and concentration); one that improves the gas tracking capabilities without compromising the EL readout.
In this work, we studied how small percentages of isobutane and methane influence the charge gain, EL yield and corresponding energy resolution of He-CF_4 mixtures. The detector, operated in continuous flow-mode, was irradiated with low energy x-rays and a Large Area Avalanche Photodiode (LAAPD) was used to readout the EL produced in the avalanches of a single Gas Electron Multiplier (GEM). Besides the total EL yield, the visible component of the He-CF_4 emission was also quantified by placing a borosilicate glass window on top of the LAAPD window to cut-off the UV photons.
Our results show that small percentages of both isobutane (1% to 5%) and methane (up to 10%) do not compromise the EL readout, which makes them good admixtures for EL readout gas tracking detectors based on He-CF_4.

Collaboration

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