Study of Gas Properties in GEM for Ar and CO_2 gas mixtures

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Introduction

The basic idea to study the GEMs (Gaseous Electron Multipliers) for knowing its feasibility and performance study in High Energy Physics Experiments.

Here, We are trying to study the effect of various gas mixtures in GEM by seeing its various transport properties like Townsend Coefficient, Attachment Coefficient, Drift Velocity, Longitudinal and Transverse Diffusion coefficients for electrons.

Specifications and Gas Mixtures in GEM detector

We have taken Ar and CO_2 gas mixtures having composition like this : Ar 100%, CO2 100%, Ar+CO2 90%+10%, Ar+CO2 80%+20%
Ar+CO2 70%+30%, Ar+CO2 60%+40%
Ar+CO2 50%+50%.

Simulation Tools used

We have used the ANSYS 3D, which is available in our BHU lab, Also we have installed GARFIELD++ for simulation study in our Computer Facility Chamber.

Results and Discussions

In order to study the gas properties for an electron, the gas mixtures are kept at room temperature and 1 atm. pressure. We have selected different combination of Ar and CO_2 which are most commonly used. For this study Magboltz simulation code is used.

In Figure 1 the drift velocity for an electron is plotted as a function of electric field. It is observed in this figure that even a small amount of CO_2 significantly changes the drift velocity. It is minimum for pure Ar and maximum for Pure CO_2 at higher electric fields. But at low electric fields the combination is better.

Figure 2 shows the electron townsend coefficient for different gas combinations. It is observed that the townsend is low for pure Ar and for pure CO_2. Also there is a high increase by adding some amount of CO_2 in Ar.

Figure 3 shows the electron's attachment coefficient for different gas mixtures. It is observed that the attachment coefficient is zero for pure Ar and is maximum for pure CO_2 at high electric fields and it can be controlled by changing the gas combination.

Figure 4 and Figure 5 show the longitudinal and transverse diffusion coefficients for different gas mixtures. Both these coefficients are important while considering the detector's position resolution and gain. It is shown in these figures that both the diffusion coefficients are maximum for pure Ar and minimum for pure CO_2. Adding a small amount of CO_2 drastically improves the diffusion.

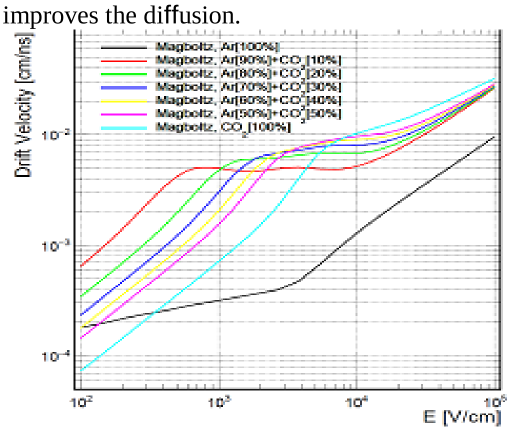

Figure 1: Electron's Drift Velocity as a function of Electric Field

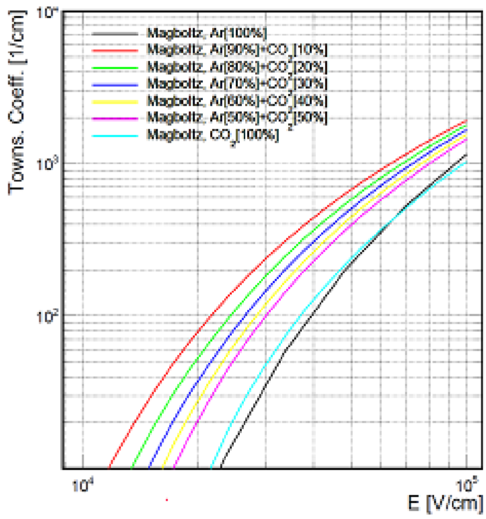

Figure 2: Electron's Townsend Coefficient as a function of Electric Field

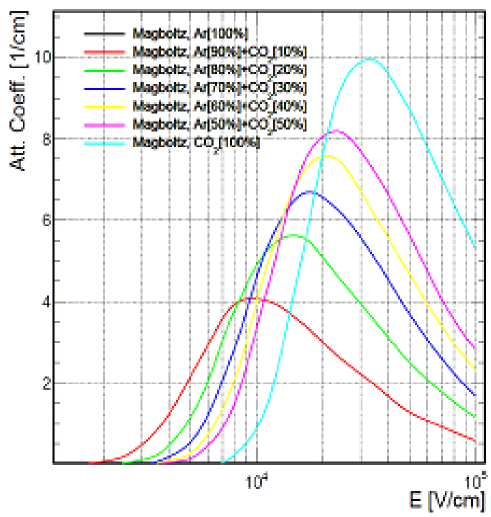

Figure 3: Electron's Attachment coefficient as a function of Electric Field

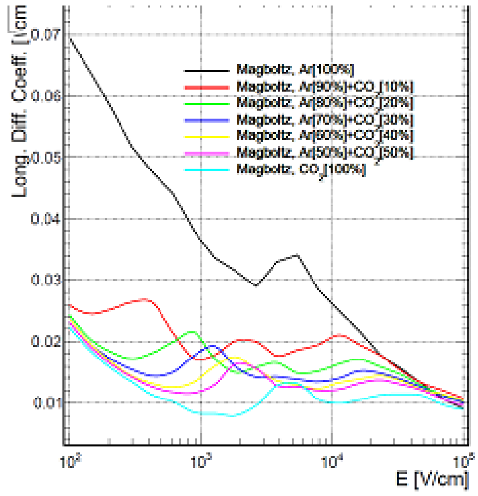

Figure 4: Electron's longitudinal diffusion constant as a function of Electric Field.

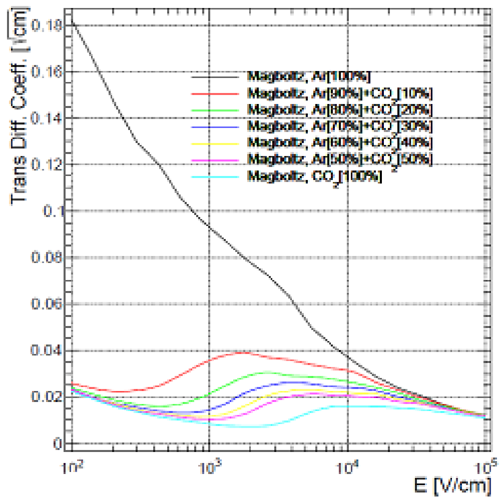

Figure 5: Electron's transverse diffusion constant as a function of Electric Field.

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