

# Polymeric Insulation for High Voltage DC Application

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## Introduction

With growing interests in renewable energy, high voltage DC transmission has become a hot topic worldwide. Charge accumulation under high voltage DC is a major issue as its presence distorts the electric field, leading to premature failure. Significant reduction in DC flashover voltage has been observed by various studies and its maximum decrease may reach ~40-50% compared to AC or short-term electric strength. We aim to chemically treat polymeric insulation and change charge transport characteristics of the material via fluorination process. In doing so, exceptional surface properties similar to fluoropolymers can be achieved without compromising the bulk characteristics of the original polymeric insulation. The modifications in chemical components at the surface of polymeric insulation should in turn lead to corresponding modifications in electrical properties of the surface and suppress the charge accumulation.

Various fluorinating conditions will be experimentally investigated and the fluorinated samples will be electrically characterised and tested, so an optimal processing condition can be achieved to meet practical requirements as DC insulating material. Modelling and simulation of electric field distribution with new developed insulating material have been planned to help design an insulation spacer in high voltage DC GIS systems.

## Simulation Model

In this present paper, fluorinations of epoxy resins were carried out to suppress charge accumulation and consequently enhance flashover voltage. A surface flashover model with finger-like electrodes has been developed using COMSOL Multiphysics 3.5. Figure 1 shows the sample with electrodes arrangement geometry and the region for analysis. The distance between the two electrodes is 8mm. The maximum electric field on the surface as well as inside the bulk of epoxy samples were performed for each fluorinating conditions. Identifying the influence of each fluorinated surface thickness on the electric field and current density will help to determine the influence of this modification on the electrical properties at the surface of polymeric insulation.

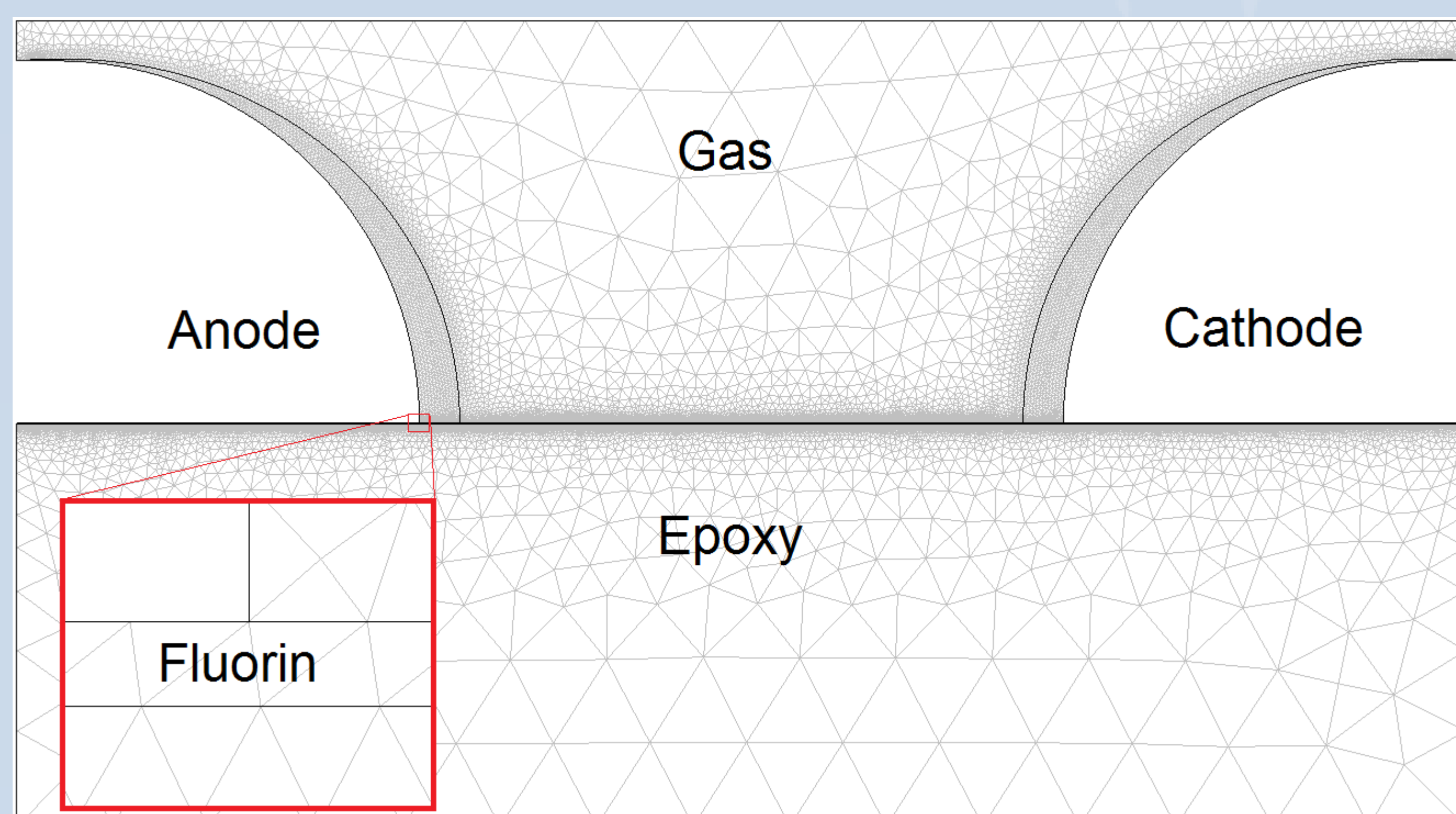


Figure 1: Analysis model for surface flashover of fluorinated epoxy using finger electrodes and finite element meshes

## Simulation Results

To accurately determine the electric field and current density, a more refine mesh area are made at the tip of both anode and cathode, and also on the layer of fluorinated surface. Figure 2 to Figure 5 show the simulation results for different fluorinated surface thickness on epoxy resin.

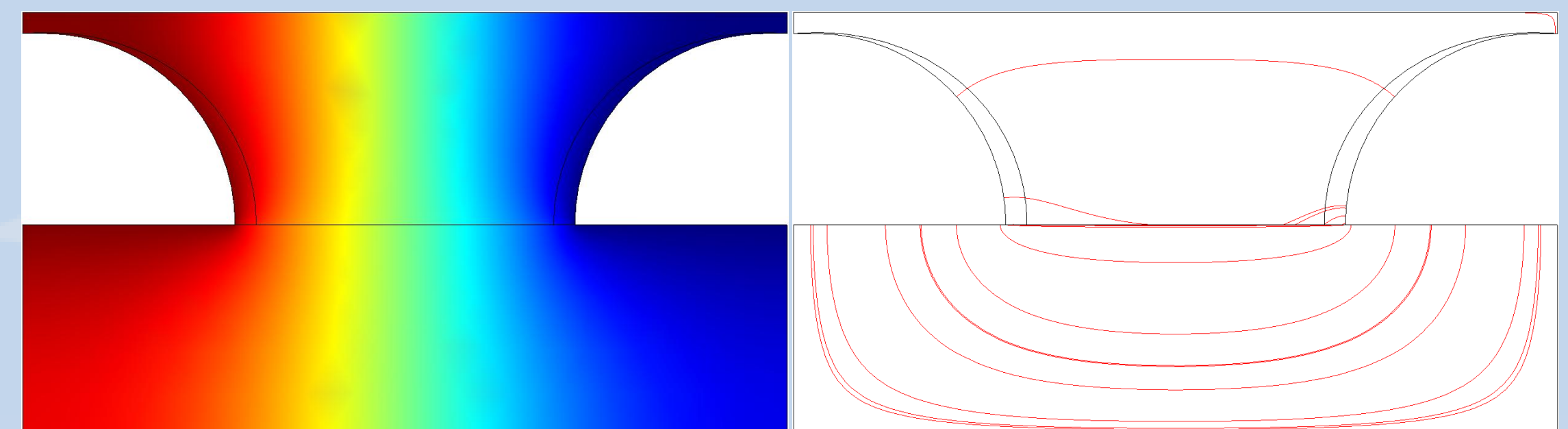


Figure 2: Electric field and current density for 0μm fluorinated thickness

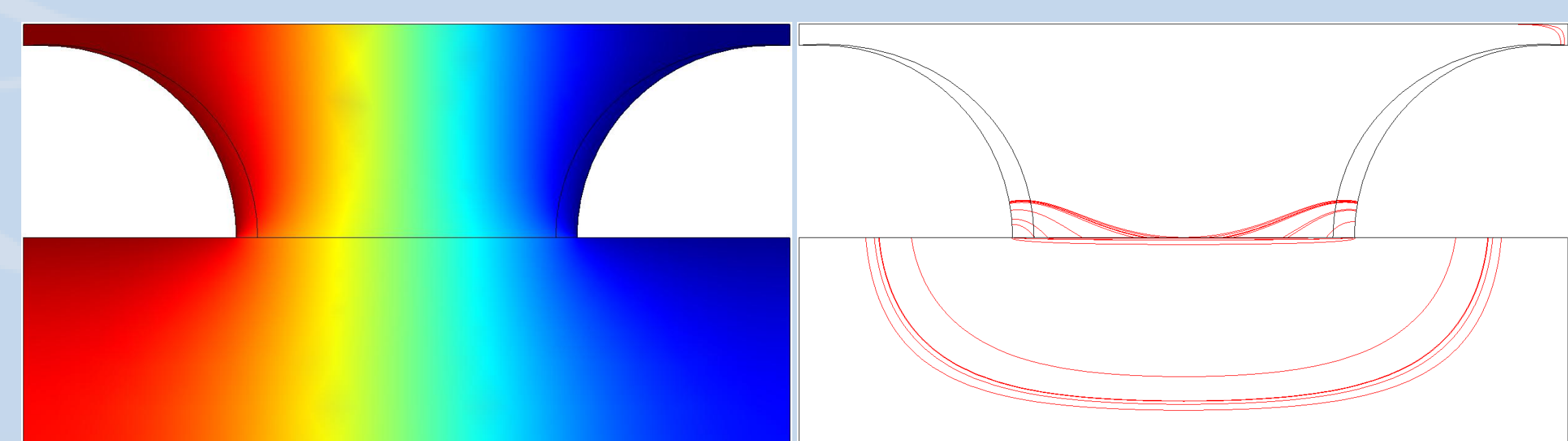


Figure 3: Electric field and current density for 2μm fluorinated thickness

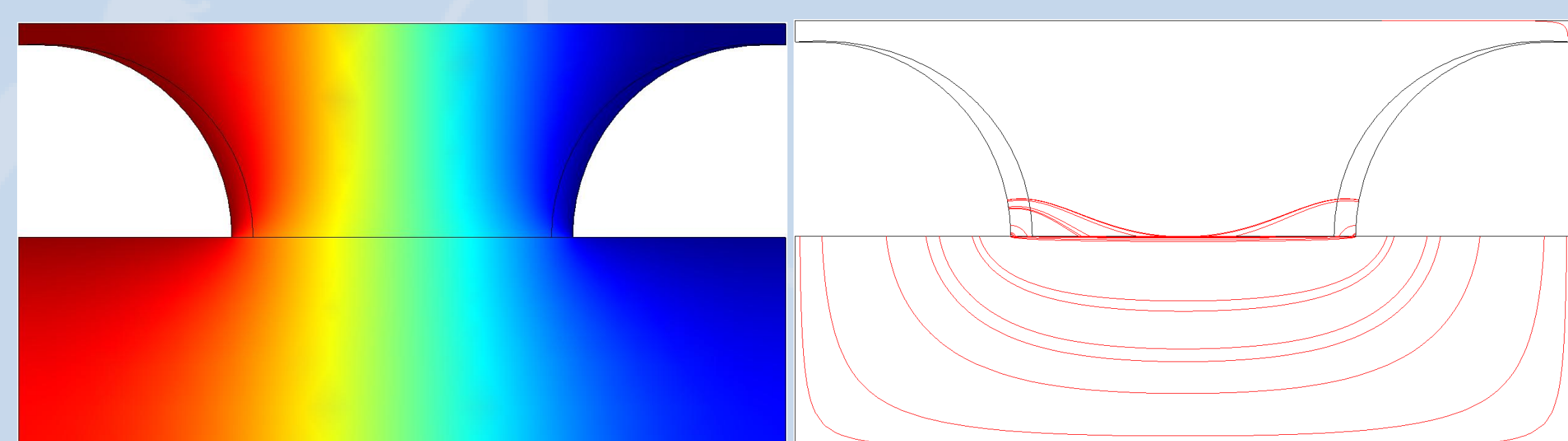


Figure 4: Electric field and current density for 5μm fluorinated thickness

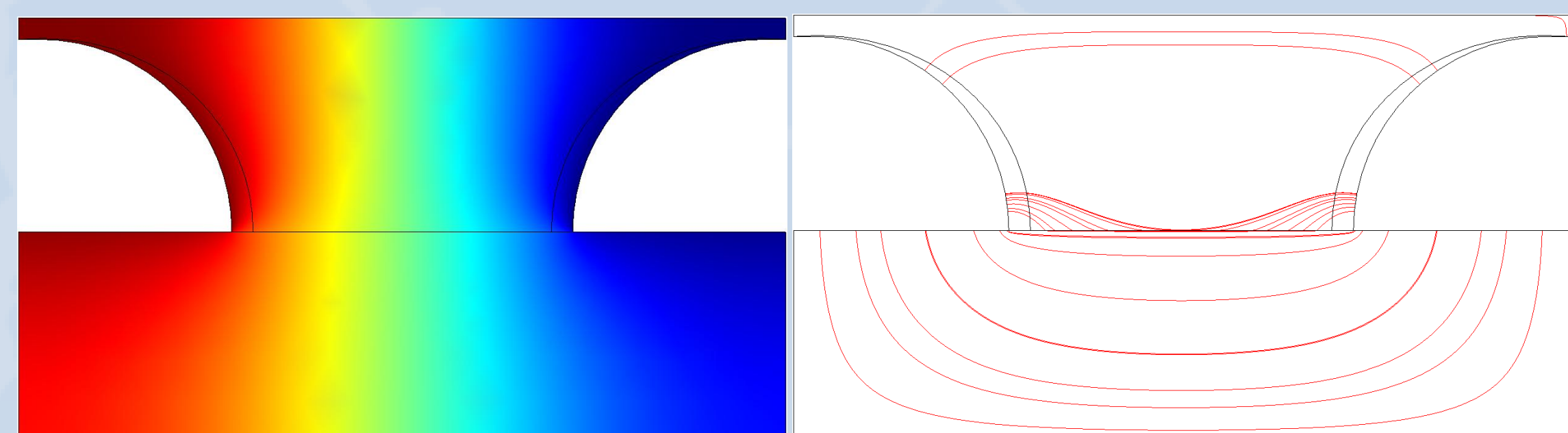


Figure 5: Electric field and current density for 10μm fluorinated thickness

## Discussions

- There is a slight reduction in electric field inside epoxy resin with the introduction of fluorinated surface layer on epoxy resin
- Current density is concentrated more on the surface of fluorinated epoxy which have better conductivity than bulk.
- The fluorinated surface thickness of 2-10μm is much thicker than the actual thickness of around 0.5μm

## Conclusions & Future Works

- This work has demonstrated different influences of fluorinated surface layer on electric field and current density distribution.
- More work is to be done on this model. A narrow down version of this model is to be made in order to do meshing of thinner fluorinated surface. The model is to be extended until breakdown point.
- Experiments are to be carried out on actual fluorinated epoxy samples to verify the simulation results.