Conductor-insulator composite films were prepared by cathodic electro-deposition of a dispersion of conductive carbon black and epoxy resin onto tricationic-phosphated galvanized steel panels. The prepared composite films were then characterized regarding their surface and bulk fractality using the electrochemical impedance spectroscopy. A novel method was offered for the first time to determine the fractal dimension of the conductive paths in the bulk of the films. It was found that increasing the carbon black content from 2 to 8 percent causes the fractal dimension of the electro-active region at the film-solution interface (2D-fractal dimension) to increase from 1.47 to 2.61 while it results in a decrease of the fractal dimension of the conductive paths inside the composite films (3D-fractal dimension) from 2.6 to 2.27.

**Keywords**: Conductor-insulator composite films; Electro-deposition; Electrochemical impedance spectroscopy; Fractal dimension

1. **INTRODUCTION**

Conductive coatings and composites have found a variety of applications in electrostatic dissipation, electromagnetic interference shielding, and other diverse applications (Sichel 1982). A big share in these materials belongs to carbon black-polymer composites. These composite materials, as evident from their nomenclature, consist of a polymeric matrix in which, carbon black particles/aggregates are dispersed and distributed as homogeneous as possible. The carbon black used in these materials should have a high electrical conductivity. The electrical transport through these composites is believed to occur via the inter-connected...