Physicochemical Characterization of Fluoropolymer-Based Insulating Thin Films

Jakub Černohous, Ondřej Michal, and Jaroslav Hornak [a)]

University of West Bohemia, Faculty of Electrical Engineering, Department of Materials and Technology, Pilsen, Czech Republic

[a)] Corresponding author: jhornak@fel.zcu.cz

Abstract. This paper investigates the characterization of selected fluoropolymers (PTFE, FEP, PFA, and ETFE) and their role in modern electrical engineering, with a focus on photovoltaic systems. Due to their excellent dielectric properties and high chemical stability, these materials are suitable for the construction of solar panels, where they serve as protective layers or electrical insulation. The study employs spectroscopic, dielectric, and mechanical methods to analyze the influence of chemical composition on the properties of insulating thin films. FTIR analysis clearly revealed that the fully fluorinated materials (FEP, PFA, PTFE) exhibit nearly identical spectra, except for a distinct peak for FEP and PFA in the region around 980 cm^{-1}. ETFE, as a partially fluorinated material, showed a different profile. Mechanical tensile tests indicated that ETFE achieves the best results. FEP and PFA possess high elongation but low ultimate tensile strength. PTFE exhibits high ultimate tensile strength but very low elongation at break. Furthermore, BDS measurements over a wide frequency and temperature range demonstrated that the presence of hydrogen in ETFE significantly enhances its dielectric response and relaxation dynamics compared to the stable behavior of fully fluorinated polymers, whose dynamics are primarily governed by the steric influence of their side groups.