World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:19, No:05, 2025

Influence of Molecular and Supramolecular Structure on Thermally Stimulated Short-Circuit Currents in Polyvinylidene Fluoride Films

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Abstract : Relaxation processes in polyvinylidene fluoride (PVDF) films were studied by the method of thermally stimulated fractional polarization currents (TSTF). The films were obtained by extrusion of a polymer melt followed by isometric annealing. PVDF granules of the Kynar-720 brand (Atofina Chemicals, USA) with a molecular weight of Mw=190,000 g•mol-1 were used for the manufacture of films. The annealing temperature was varied in the range from 120 °C to 170 °C in increments of 10 °C. The dependences of the degree of crystallinity of films (χ) and the intensity of thermally stimulated depolarization currents on the annealing temperature (Toc) are investigated. The TSTF spectra were obtained at the TSC II facility (Setaram, France). Measurements were carried out in a helium atmosphere, and the values of currents were determined by a Keithley electrometer. The annealed PVDF films were polarized at an electric field strength of 100 V/mm at a temperature of 31°C, after which they were cooled to 26°C, at which they were kept for 1 minute. During depolarization, the external field was removed, and the short-circuit sample was cooled to 0°C. The thermally stimulated short-circuit current was recorded during linear heating. Relaxation processes in PVDF films were studied in the temperature range from 0 – 70 °C. It is shown that the intensity curve of the peaks of TST FP has a course that is the reverse of the dependence of the degree of crystallinity on the annealing temperature. This allows us to conclude that the relaxation processes occurring in PVDF in the 35°C region are associated with the amorphous part of the structure of PVDF films between the layers of the spherulite crystalline phase.

Keywords : molecular and supramolecular structure, thermally stimulated currents, polyvinylidene fluoride films, relaxation processes
Conference Title : ICPC 2025 : International Conference on Polymers and Composites
Conference Location : Istanbul, Türkiye
Conference Dates : May 06-07, 2025