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Electron Transport Mechanisms in Polyethylene Terephthalate Membranes

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Received Januari 3, 2022
Revised March 1, 2022
Accepted May 14, 2022

This paper describes carrier transport mechanisms in a polyethylene terephthalate (PET) films and porous PET-based membranes (PMs) obtained by irradiating of pristine PET film with swift heavy ions and subsequent chemical etching in an alkali (NaOH) solution. The obtained PMs had through nanochannels (pores) with an average diameter of 720−750 nm. We observed that in the temperature range 240−300 K, current−voltage characteristics $I(V)$ of the initial Cu|PET|Cu structure obeyed the improved Mott−Gurney law, which is based on the Mark−Helfrich model for a space-charge-limited current (SCLC) mechanism of electron transport. It was found for the first time that creation of nanochannels in the PMs resulted in significant increase in the electric current density (by about 3 orders of magnitude) while maintaining validity of the SCLC mechanism. The enhanced current density is explained by the formation of a highly-conductive layer along the inner surface of nanochannel's walls covered with carboxyl end groups, which are created by alkaline hydrolysis. According to the model, surface states formed by these groups provide drift of additional electrons injected from the copper electrodes under the action of the bias voltage.

Keywords: polyethylene terephthalate, electron transport, space-charge-limited current mechanism, Mark–Helfrich injection model.