Electrical Conduction of Biphenyl Polyimides with an Aromatic or an Alicyclic Diamine

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Introduction: In order to design useful polyimides (PIs) of high electrical performance including electrophotographic and energy conversion applications, it is essential to elucidate the mechanism of electrical conduction in the materials. Experimental investigations on dark current in Kapton polyimide film have been reported earlier[1], leading to the conclusions that the theoretical curve from Åghopping modelÅhfits well for the dependence of the current on the electric field and the charge carrier may be generated from the charge transfer complex (CTC) in a ground and an excited state, respectively.

In this study, the electrical conduction current of Upilex-S, PI(s-BPDA/PDA), and PI(s-BPDA/CHDA) films at temperatures of 40 - 200Åé is obtained as a function of electric field. An attempt is made to fit the experimental results to the theoretical values for the electronic hopping conduction.

Experimental, Results and Discussion: The electrical conduction of Upilex-S, PI(s-BPDA/PDA), and PI(s-BPDA/CHDA) films was measured under steady-state conditions in temperature range 40 - 200Åé.

The field (E) dependence of current (I) was analysed by an electronic hopping conduction model:

$$I = I_0 \sinh(qEa/2kT), \quad \text{where } I_0 = 2SqnaÉÀexp(-U/kT)$$

The two kinds of apparent activation energies U_l and U_h were obtained at lower and higher temperatures, respectively (see Fig. 1). In Fig. 1 U_l corresponds to the activation energy of transport process for CTC in a ground state, while U_h to the activation energy of generation and transport process for CTC in an excited state. The relation between the values of U_h and the emission spectra were investigated

Values of the jump distance (a) were ca. 40 Å for PI(s-BPDA/PDA) and ca. 10 Å for PI(s-BPDA/CHDA). The wide-angle X-ray diffract -ion for PI(s-BPDA/CHDA) gave a more ordered molecular aggregation than that for PI(s-BPDA /PDA).

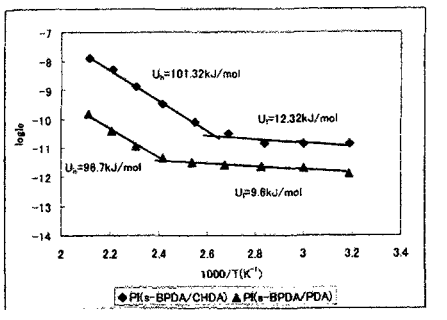

Fig. 1 Temperature dependence of I_0

1) M. Kochi et al., The Fifth Proceeding of China-Japan Seminar on Advanced Aromatic Polymers (2002), pp. 153-157.