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Molecular mobility and energy activation of polyvinyl butyral by dynamic mechanical analysis: towards storage improvement applications

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The growing demand of polymeric materials for energy and storage applications requires not only the characterization of the temporal and/or the temperature dependences of their physicochemical properties (structural, morphological, mechanical, electric, etc.); it is also necessary to complement the study with the characterization of their molecular mobility. Polymers are semicrystalline materials with an amorphous phase far away to the thermodynamic equilibrium. The molecular mobility is a consequence of this search of the polymer towards a thermodynamic equilibrium. In this work, we study the molecular mobility of the polyvinyl butyral, or PVB. The principal applications of the PVB are in glass industry as mechanical coats. Nevertheless, this polymer is an interesting contender for energy storage applications thanks to its physicochemical properties. To go further, we first obtained experimental measurements of the viscoelastic behavior by Dynamic Mechanical Analysis (DMA). The tests have been performed in a tensile mode with a heating rate of 2 K/min, for frequencies of 0.1, 1, 10 and 100 Hz. The samples measures 21 mm in length, 7 mm in width and 0.08 mm in thickness. The experimental results have been computed to obtain the relaxation times and then, a quantitative study of the molecular mobility. Additionally, and considering the cooperative molecular motions theory, we calculate the activation energy of the PVB's glass transition. This activation energy is a function of the average molecular weight and it strongly depends on the temperature in a particular range. So, the temperature dependence of the activation energy of the PVB's glass transition is analogous to the temperature dependence of the cooperativity of its molecular mobility.

Keywords: Molecular activity, activation energy; polyvinyl butiral; dynamic mechanical analysis