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SHORT COMMUNICATION

Effect of compression pressure on mechanical and electrical properties of polyaniline pellets

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While conductivity and other electrical properties are key parameters in the design of polymer electronics, equally important mechanical properties of conducting polymers have rarely been reported. The influence of preparation conditions of polyaniline pellets on mechanical and electrical properties was therefore studied. Conductivity of polyaniline is commonly measured using pellets prepared by the compression of powder. It is shown that a pressure of at least 300 MPa is needed to obtain a reliable value of conductivity. At lower pressures, the samples have lower apparent conductivity, density, Young modulus, and hardness. Above the compression limit of 300 MPa, these parameters become constant, except for the density. The same behavior was observed both for conducting polyaniline hydrochloride and for the non-conducting polyaniline base. The puzzling observation that density of the pellets decreased as the compression pressure increased is discussed considering the relaxation processes.

Keywords: conducting polymer, hardness, mechanical properties, Young modulus, polyaniline, density

Polyaniline (PANI) is currently prepared by chemical oxidation of aniline and it is obtained as a powder (Stejskal & Gilbert, 2002; Stejskal et al., 2010). The room-temperature conductivity is the most important parameter characterizing this conducting polymer; the PANI powder is compressed into pellets before such a measurement, the compression pressure typically being 700 MPa (7 t cm^{-2}). A change in the morphology of the PANI at even lower pressures has been reported in literature (Adetunji et al., 2009). It is the purpose of this study to check if this method of sample preparation yields reproducible conductivity measurements, and if the conductivity value so observed depends on the procedure for sample preparation, viz. on the compression pressure. In the present communication, it is determined whether there is a minimum pressure needed for obtaining reliable conductivity values and if there is a maximum pressure which should be avoided to prevent sample damage. This study has been inspired by recent measurements of mechanical parameters, viz. Young moduli (Valentová & Stejskal, 2010), which were found to be invariant only if a pressure higher than 300 MPa is used for the preparation of pellets. Electrical properties of PANI have been investigated in literature in detail (Skotheim & Reynolds, 2007). The present report draws attention to the fact that compressed PANI powders can also be regarded as materials with mechanical properties often comparable with those of current commodity polymers. Mechanical properties of conducting polymer are of great importance for its applications in electronics and distinguish conducting polymers from inorganic systems.

For the purpose of the present study, PANI was prepared by the oxidation of 0.2 M aniline hydrochloride with 0.25 M ammonium peroxydisulfate in an aqueous medium at room temperature (Stejskal &

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