Positive and negative ion desorption system for electron stimulated desorption from polymers

Luiz Antonio V. Mendes[1] (PG), Caroline Arantes[1] (PG), Stenio D. Magalhães[2] (PQ), Maria Luiza M. Rocco[1,*] (PQ)

[*]*luiza@iq.ufrj.br*

[1]*Instituto de Química, Universidade Federal do Rio de Janeiro, Cidade Universitária, Ilha do Fundão, 21949-900, Rio de Janeiro, RJ, Brazil*

[2]*Instituto de Física, Universidade Federal do Rio de Janeiro, Cidade Universitária, Ilha do Fundão, 21941-972, Rio de Janeiro, RJ, Brazil*

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Introdução

The study of the interaction of electrons with polymers is a topic of great interest since it is concerned with many important technological applications, as electron beam lithography employed in mask fabrication. It is also a relevant topic for the fabrication of organic electronic devices, since organic and polymeric films have already shown their potentialities. Despite its importance, not only as an attempt to understand the degradation mechanisms leading to changes in the physical and chemical properties of polymers, but also in improving our knowledge about the interaction itself, very few data can be found in the literature in comparison with the abundance of studies using photons. In the present work we report, for the first time within our knowledge, positive and negative ESID (Electron Stimulated Ion Desorption) results on poly(vynil chloride) (PVC) induced by a variable energy electron beam, using the time-of-flight mass technique for ion analysis.

Resultados e Discussão

Positive and negative ion desorption experiments were performed on polymeric samples using a recently implemented system. The experimental set up includes a sample manipulator and a time-of-flight mass spectrometer (TOF-MS) housed in an UHV chamber. The home-made TOF-MS employed in the present work consists basically of an electrostatic ion extraction system, a collimating electrostatic lens, a drift tube and a pair of microchannel plate (MCP) detectors, in chevron assembly. After extraction, positive and negative ions travel through three metallic grids, before reaching the MCP. The potentials were chosen such that ion optics simulations performed using the Simion program, even assuming ions with up to 10 eV initial kinetic energy and initial angular spread from -90 to +90 degrees, resulted in a collection efficiency of 100%. The polymer samples were irradiated by a pulsed beam of monoenergetic electrons with variable energies (EG-2, 5 - 1000 eV, Kimball Physics). Two different experimental setups were used for positive ion analysis: a) constant positive potential applied to the sample; b) pulsed potential. In the first case the pulsed electron beam had a frequency of 80 kHz and a minimal pulse width of 20 ns. A pulse generator simultaneously provided a signal to the control grid of the electron gun, thus creating the pulsed electron beam, and a logic start signal to the time-to-digital converter. The output signal of the detector was processed by standard pulse electronics and used to provide a stop signal to the TDC, with a time resolution of 1 ns/ch. To use the low energy beams provided by the electron gun, the second experimental setup was employed, in which the sample potential is pulsed in order to remove it during the transit time of the electrons from gun to sample. The electron gun pulse generator is now externally triggered by logical pulses of a high voltage pulse generator. In order to study negative ion desorption the second experimental setup was also used, with only a sign inversion of the potentials. To obtain a further insight into the mechanisms leading to positive and negative ionic desorption in PVC we have measured spectra at different impact electron energies. Ionic desorption mass spectra as a function of the electron energy and covering a broad mass interval will be presented and discussed within the ASID (Auger Stimulated Ion Desorption) mechanism.

Conclusões

Electron stimulated ion desorption in PVC has been studied in the energy range of 500 to 6000 eV, using a time-of-flight mass spectrometer. Partial ion yield curves were obtained for the main fragments. The ASID mechanism seems to play a major role in positive ionic desorption of PVC as induced by electron impact.

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