Dielectric Spectroscopy of a Stretched Polymer Glass: Heterogeneous Dynamics and Plasticity

Caroline Crauste-Thibierge*[1], Roberto Perez-Aparicio[1], Denis Cottinet[1], Loïc Vanel[2], Paul Sotta[3], Jean-Yves Delannoy[4], Didier Long[5], and Sergio Ciliberto[1]

[1]Laboratoire de Physique de l'ENS Lyon (Phys-ENS) – CNRS : UMR5672, École Normale Supérieure (ENS) - Lyon – 46 allée d'Italie 69007 Lyon, France

[2]Institut Lumière Matière (ILM) – CNRS : UMR5306, Université Claude Bernard - Lyon I (UCBL) – UMR5306 CNRS Université Claude Bernard Lyon 1 Domaine Scientifique de La Doua Bâtiment Kastler, 10 rue Ada Byron 69622 Villeurbanne CEDEX, Franc, France

[3]Laboratoire Polymères et Matériaux Avancés (LPMA) – CNRS : UMR5268, Solvay (France) – 69192 ST FONS CEDEX, France

[4]Laboratoire Polymères et Matériaux Avancés (LPMA) – CNRS : UMR5268, Solvay (France) – Plateforme Axel'One PMI 87, rue des frères Perret 69190 Saint Fons Cedex, France

[5]Laboratoire Polymères Matériaux Avancés, UMR5268, joined CNRS-Solvay Laboratory (LPMA) – CNRS UMR 5268 – 85 rue des freres Perret – BP62 69192 Saint Fons Cedex, France

Abstract

We study the dielectric relaxation of polycarbonate (PC) at room temperature under imposed strain rate γ, above the yield stress, and up to 13% strain. We find that the dielectric response of stretched PC behaves as if it was heated up at a temperature just below its glass transition temperature, Tg around 423 K for PC. Indeed, in the frequency range of our experiment (10ˆ–2 and 10ˆ3 Hz), the dielectric response of the stretched PC at room temperature superimposes to the dielectric response of PC at a temperature T_a (gamma_dot) $<$ Tg, which is a function of strain rate. Specifically we observe that at T_a the dominant relaxation time tau_alpha(T_a) of PC at rest is related to gamma_dot in such a way that tau_alpha(T_a) $\sim$ 1/gamma_dot at and beyond the yield point. In our experiment, 10ˆ–5 sˆ–1 $<$ gamma_dot$<$ 10ˆ–3 sˆ–1, the temperature shifts Tg – T_a are of a few kelvin. The mechanical rejuvenation modifies the dielectric response at frequencies smaller than 10 Hz, whereas for higher frequencies the spectrum is only slightly modified.

*Speaker