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Ultrafast Nanocalorimetry and Superheating in Linear Polymers[1]

CHRISTOPH SCHICK, ALEXANDER MINAKOV, ANDREAS WURM, University of Rostock — To study phase transition kinetics on submillisecond time scale a set of new membrane gauges for ultrafast scanning nanocalorimetry were constructed. Controlled ultrafast cooling, as well as heating, up to 10E6 K/s was attained. The characteristic rate R0 corresponding to the quasi-static limit of the temperature change in the membrane-gas system was determined. The rate R0 equals 10E5 K/s for the different gauges in helium gas. The method was applied for the measurements of the superheating phenomenon in a set of linear polymers iPS, PBT, PET, iPP. A power law relation between the superheating and the heating rate was observed in the broad range 10E-2 – 10E4 K/s of the heating rates. A limiting superheating of about 10% of the melting temperature was observed at rates above 10E4 – 10E5 K/s. This limit depends on the annealing conditions before the sample melting. The observed superheating limit, as well as the power law, can be accounted for the internal stresses induced by the superheating near the crystalline-amorphous interface in semicrystalline polymers, which are related to the thermal expansion gradients inherent for a semicrystalline material.

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