NMR INVESTIGATION OF DYNAMICS AND ORDER OF POLYMERS UNDER MECHANICAL STRESS

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Local order and dynamics in polymers under mechanical stress is studied by NMR. Permanent magnets in a Halbach arrangement permit NMR investigation without the limits present in high-field NMR. In particular the confined stray field permit the application of NMR in a stretching apparatus and a rheometer. Mechanical stress on elastomers results in partial chain ordering and consequently reduced chain mobility, which results in stronger residual dipolar couplings are manifested in the stronger buildup of double quantum coherences and in a shortening of the slower component of the transverse relaxation time. The crystalline and amorphous fractions of semicrystalline polymers are distinguished by their transverse relaxation times. Under mechanical load there is a significant shortening of the transverse relaxation time of the amorphous fraction, which partially relaxes with time, when the load is kept constant. In an alternative experiment mechanical stress is induced on a polymer melt or solution in a Couette cell. This requires a dedicated high-temperature rheo-NMR probe. Changes in the polymer mobility during the melting and subsequent shear are followed in the proton T2 using a CPMG experiment. Double quantum experiments yield information on residual dipolar coupling and hence the dynamic chain order parameter.