Macro-, micro- and nanomechanical characterization of crosslinked polymers with very broad range of mechanical properties

M. Slouf[1*], V. Gajdosova[1], B. Strachota[1], A. Strachota[1], J. Nohava[2]

[1]*Institute of Macromolecular Chemistry CAS, Prague, Czech Republic*
[2] *Anton Paar TriTec SA, Vernets 6, 2035 Corcelles, Switzerland*
[*]*Corresponding author e-mail: slouf@imc.cas.cz*

We compared of macro-, micro- and nanomechanical properties of a series of eleven highly homogeneous and chemically very similar crosslined polymers [1]. By means of synthesis parameters, the mechanical properties of the samples were deliberately changed from very hard and stiff (elastic moduli of 4 GPa), through semi-hard and ductile, to very soft and elastic (elastic moduli of 0.006 GPa).

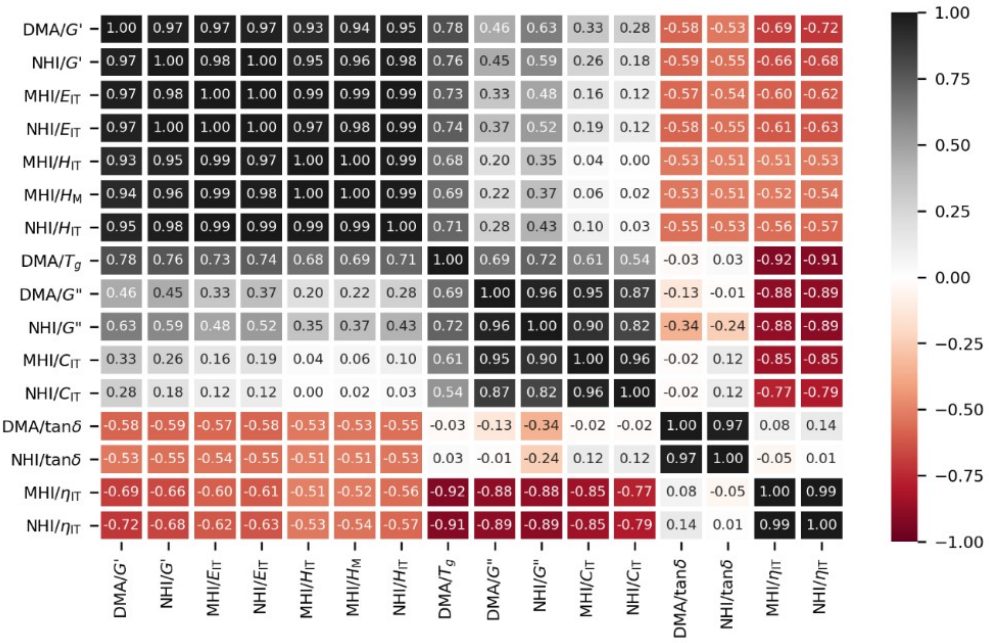

Figure 1: Correlation matrix table showing Pearson's coefficients *r* for all pairs of experimentally determined macro-, micro- and nanomechanical properties: storage and loss modulus, damping factor and glass transition temperature from dynamic mechanical analysis (DMA/*G*', DMA/*G*", DMA/tan(δ) and DMA/T_g), analogous properties from dynamic nanoindentation experiments (NHI/G', NHI/G", NHI/tan(δ)), indentation hardness, modulus, creep and elasticity from quasi-static microindentation experiments (MHI/H_{IT}, MHI/E_{IT}, MHI/η_{IT} and MHI/C_{IT}), and analogous properties from quasi-static nanoindentation (NHI/H_{IT}, NHI/E_{IT}, NHI/η_{IT} and NHI/C_{IT}).

Mechanical properties at all length scales showed similar trends (as documented in Fig. 1), which confirmed the reliability of the state-of-the art micro- and nanoindentaion methods. The observed correlations between stiffness-related and viscosity-related properties were closely connected with brittle-ductile-rubbery transitions. In the conculding remarks, we will generalize how the observed macro-micro-nano correlations work for other polymer systems, such as semicrystalline polymers, blends, and composites [2].

Keywords: microindentation, nanoindentation, local mechanical properties of polymer systems

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References

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