Effects of the Polyurethane Chemical Structure on Radiation Resistance of the Polymer Matrices in Solid-State Laser Elements

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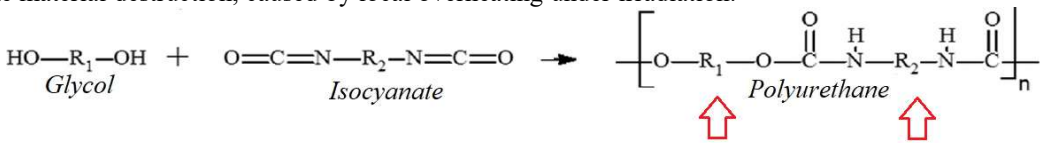
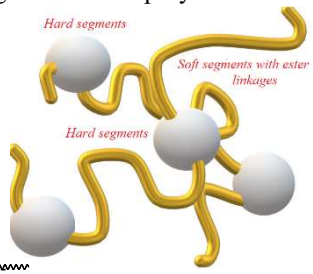
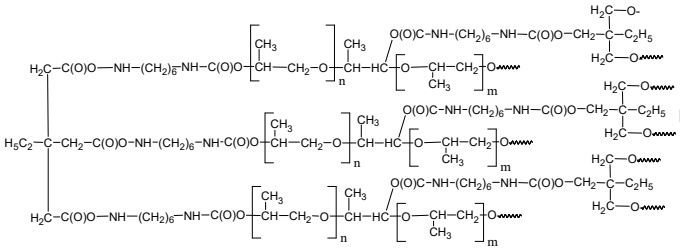
Radiation resistance of the polymer medium is of great importance for the solid-state laser active elements. This characteristic is crucially dependent on the polymer elasticity modulus and gas permeability. Lower elastic modulus and higher gas permeability result in the growth of the polymer radiation resistance due to prevention of the material destruction, caused by local overheating under irradiation.



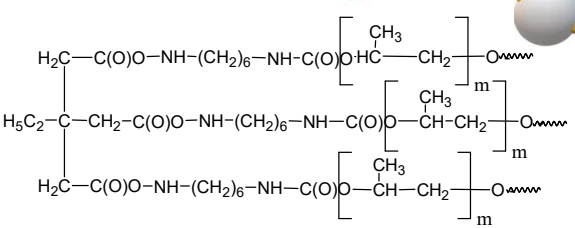


Polyurethanes possess high elasticity (low storage modulus) and high segmental mobility, which can be widely regulated by varying the chemical structure both soft and hard segments.

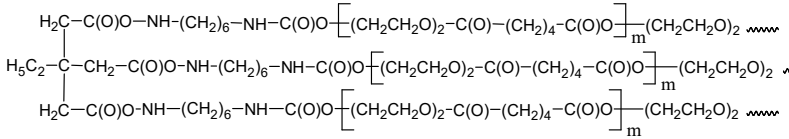
Polyurethane networks under study



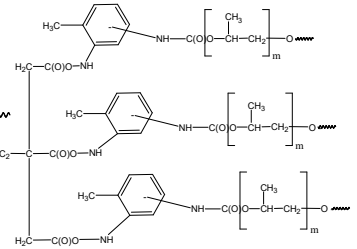
PU-1 aliphatic diisocyanate – hexamethylene diisocyanate (HMDI), trifunctional oligoether triol – oligo-oxypropylene glycol with MM 500 (OPG-500), trimethylolpropane (TMP)



PU-2 aliphatic diisocyanate HMDI, bifunctional oligoether diol – oligo-oxypropylene glycol with MM 1000 (OPG-1000), TMP

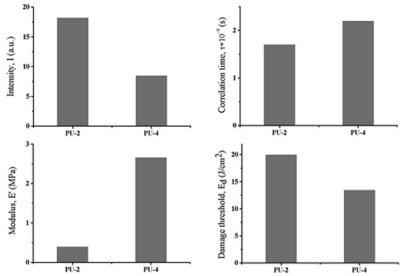


PU-3 HMDI, bifunctional oligoester diol – oligo-diethylene glycol adipate with MM 800 (ODA) and TMP



PU-4 aromatic diisocyanate - toluene diisocyanate (TDI), bifunctional oligoether diol – OPG-1000 and TMP

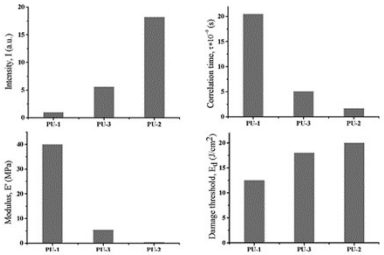
Effects of isocyanate structure



Relative integral intensity of TEMPO spectra (I) and pmp correlation time (τ) agree with storage modulus (E') and threshold of single-pulse laser damage (Ed) in the polyurethane matrices based on OPG-1000 and different diisocyanates

Effects of polyester structure

Relative integral intensity of TEMPO spectra (I) and pmp correlation time (τ) agree with storage modulus (E') and threshold of single-pulse laser damage (Ed) in the polyurethane matrices based on HMDI and polyesters of different structure



The observed good agreement between the polyurethane chemical structure and storage modulus, pmp penetrability, pmp correlation time, and also the measured values of the single-pulse laser damage threshold, allows to predict stability of further developed polyurethane-based materials under continuous laser operation