FROM SPINODAL DECOMPOSITION AND MOLECULAR DISPERSION OF POLYSILANES TO SUPER-HARD NANOCOATING

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Conformations of polymer molecules in solution crucially depend on the sign of the effective potential energy of interaction between the monomers, also known as the quality of solvent. Therefore in "poor" solvent regime, when effective attraction overwhelms, the experimental measurements of polymer sizes are complicated by the agglomeration of macromolecules, followed by precipitation. This phenomenon, also known as spinodal decomposition, causes serious problems when the goal is to determine properties of individual macromolecules. Interestingly, while in the case of carbon-based polymers the precipitation-related problems can be easily avoided with dilution, this is not the case for polysilanes, i.e. polymeric chains on basis of silicon. Although the linear polysilanes were first synthesized in early 1920's, the aggregation-related problems have hampered their studies and applicability until recently.

In the Materials Research Laboratory of University of Nova Gorica we have developed a technology to strengthen the scratch-resistance nanocoating for glass on the basis of polysilane dendritic polymers we synthesized. Through the prism of the Flory-Huggins theory, that provides a miscibility phase diagram in temperature-volume fraction variables, the quality of polymer solution can be manipulated by changing the temperature. Using Dynamic Light Scattering (DLS) and Differential Scanning Calorimetry (DSC) we have managed to show, that at temperatures in the range of 40-50 C the deagglomeration of the dendritic polysilane takes place in tetrahydrofuran (THF) [1], and the system becomes a true molecular dispersion with particles 20 nm in size [2]. Introducing such molecular dispersion into the alumina precursor solution yields an amorphous nanocomposite stabilized by a high level of strain. This resulted in an extraordinary increase of hardness and scratch resistance of the alumina – polymer nanocomposite coating that can be used for glass protection [3].

[1] A. Mavrič, A. Badasyan, M. Fanetti, M. Valant, *Sci. Rep.* 6 (2016) 35450.

[2] A. Mavrič, A. Badasyan, G. Mali, M. Valant, *Eur. Polym. J.* 90 (2017) 162-170.

[3] M. Valant, U. Luin et al. *Adv. Func. Mater.* 26 (2016) 4362–4369.