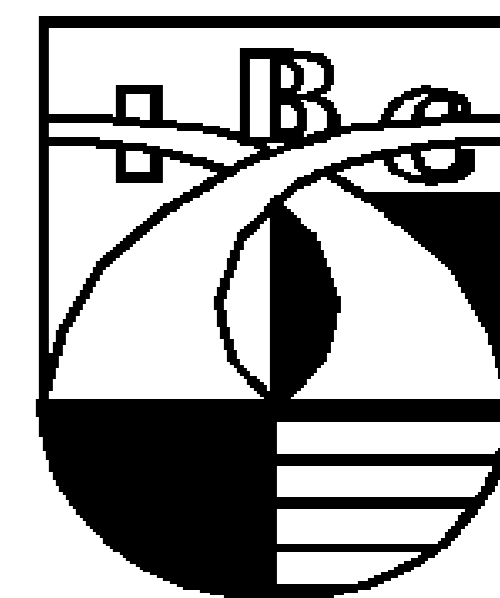


POSS-containing nanocomposites based on PU/PHPMA semi-IPNs: sorption properties and thermodynamic of interactions



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Aims

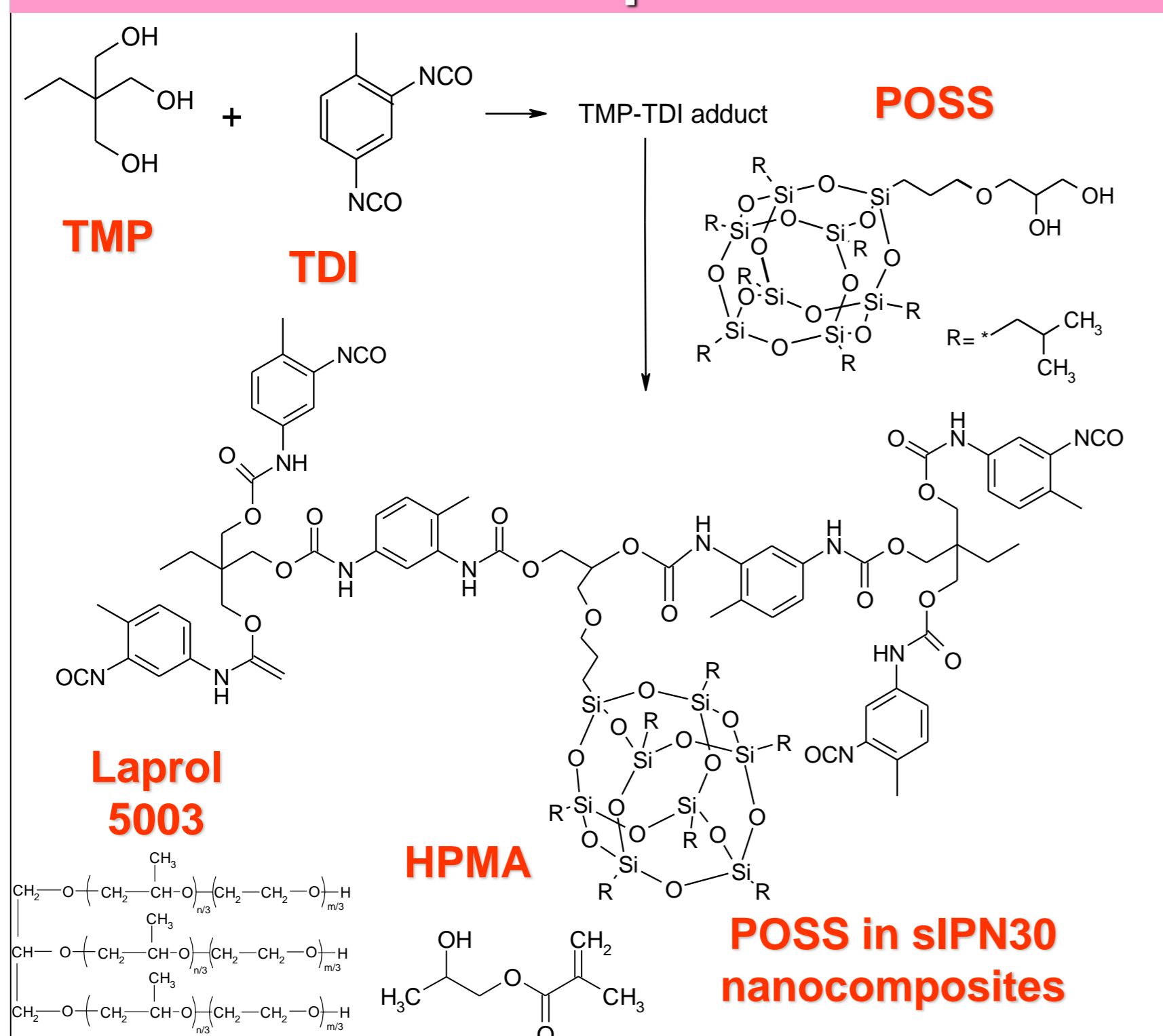
To create POSS-containing nanocomposites;
To investigate the influence of POSS content (1-10 wt. %) on the sorption properties and thermodynamic of interactions in the nanocomposites based on PU/PHPMA semi-IPN

Methods

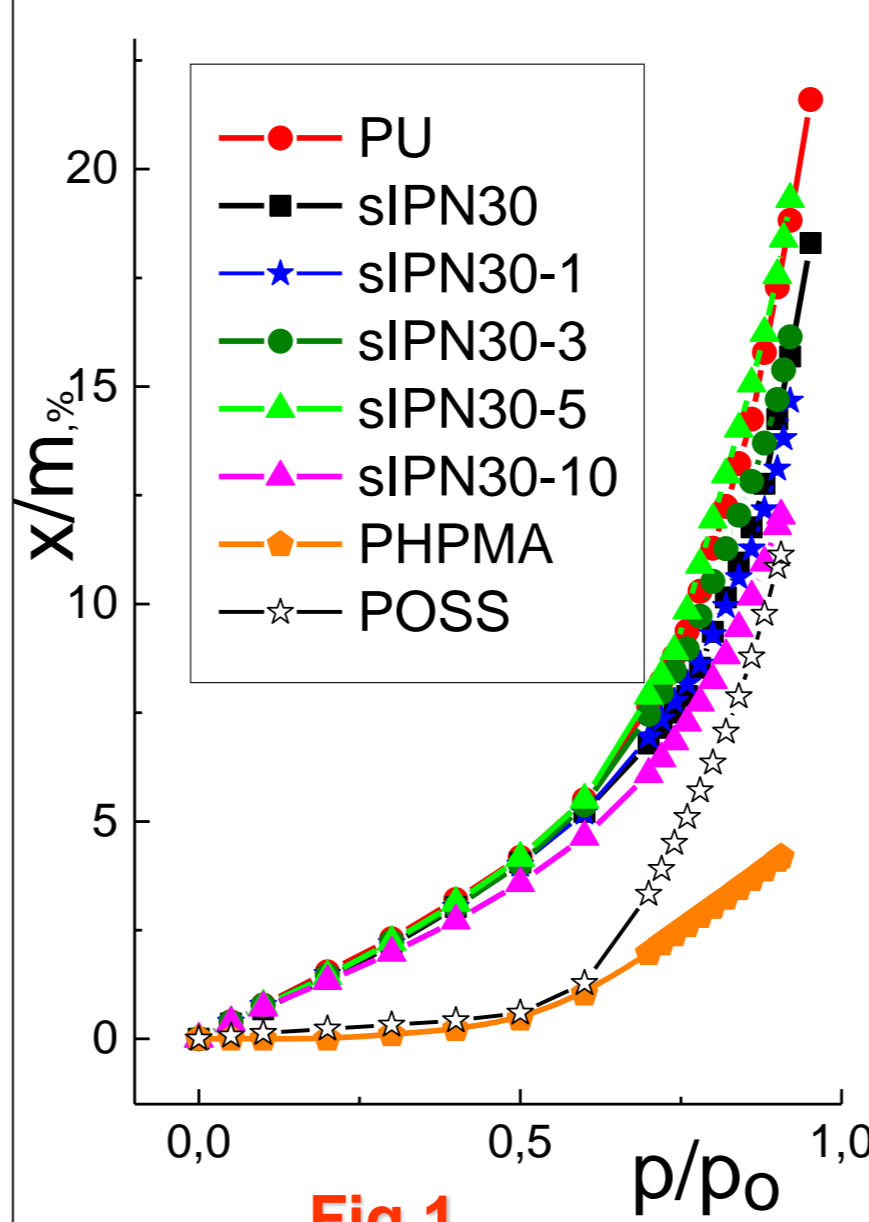
Vacuum installation with McBain balance (handmade, Ukraine)
Dynamic mechanical analyzer Q800 (TA Instruments, USA)



Synthesis of POSS-containing nanocomposites



Results & Discussion: Sorption properties and thermodynamic of interactions



In Fig.1 the isotherms of methylene chloride vapour sorption and in Fig.2 the free energy of mixing Δg^m of samples with solvent are presented; x/m is the amount of solvent relative to the dry sample; p/p_0 is the relative pressure of solvent; ω_2 is weight fraction of solvent in the sample.

The methylene chloride vapour sorption by the samples was studied using a vacuum installation and a Mc Bain balance. With increasing amount of POSS in the samples the values of vapour sorption are less in compare with native PU matrix, this means the formation of more dense structure of nanocomposites with high POSS content.

The free energy of mixing Δg^m of solvent with polymers (Fig.2) increasing with amount of POSS in the samples. The thermodynamic parameters (free energy of interactions) of PU and PHPMA were calculated. They were positive when the POSS content 1-3 wt.% (Table). This means that the polymer components are thermodynamically incompatible in the nanocomposites.

Sample	Free energy of interaction	α (DMA)
sIPN30	+4.68	0.21
sIPN30-1	+3.96	0.18
sIPN30-3	+5.29	0.16
sIPN30-5	-7.55	0.11
sIPN30-10	-11.53	0.12

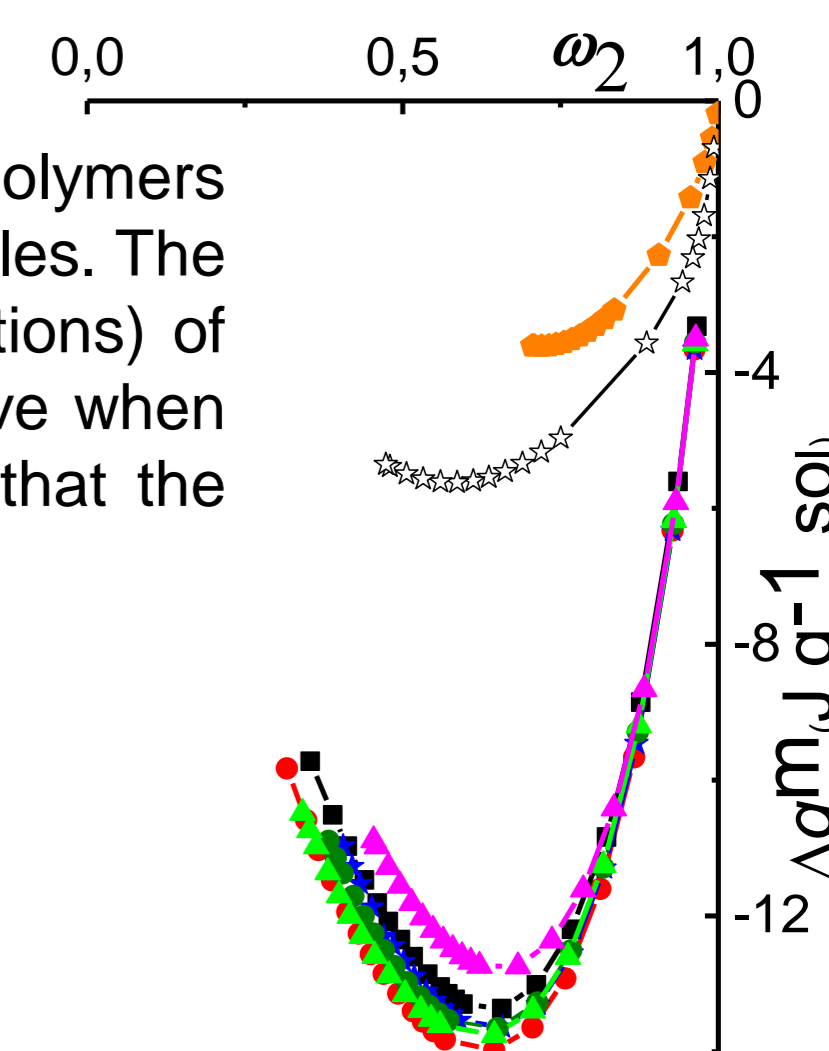
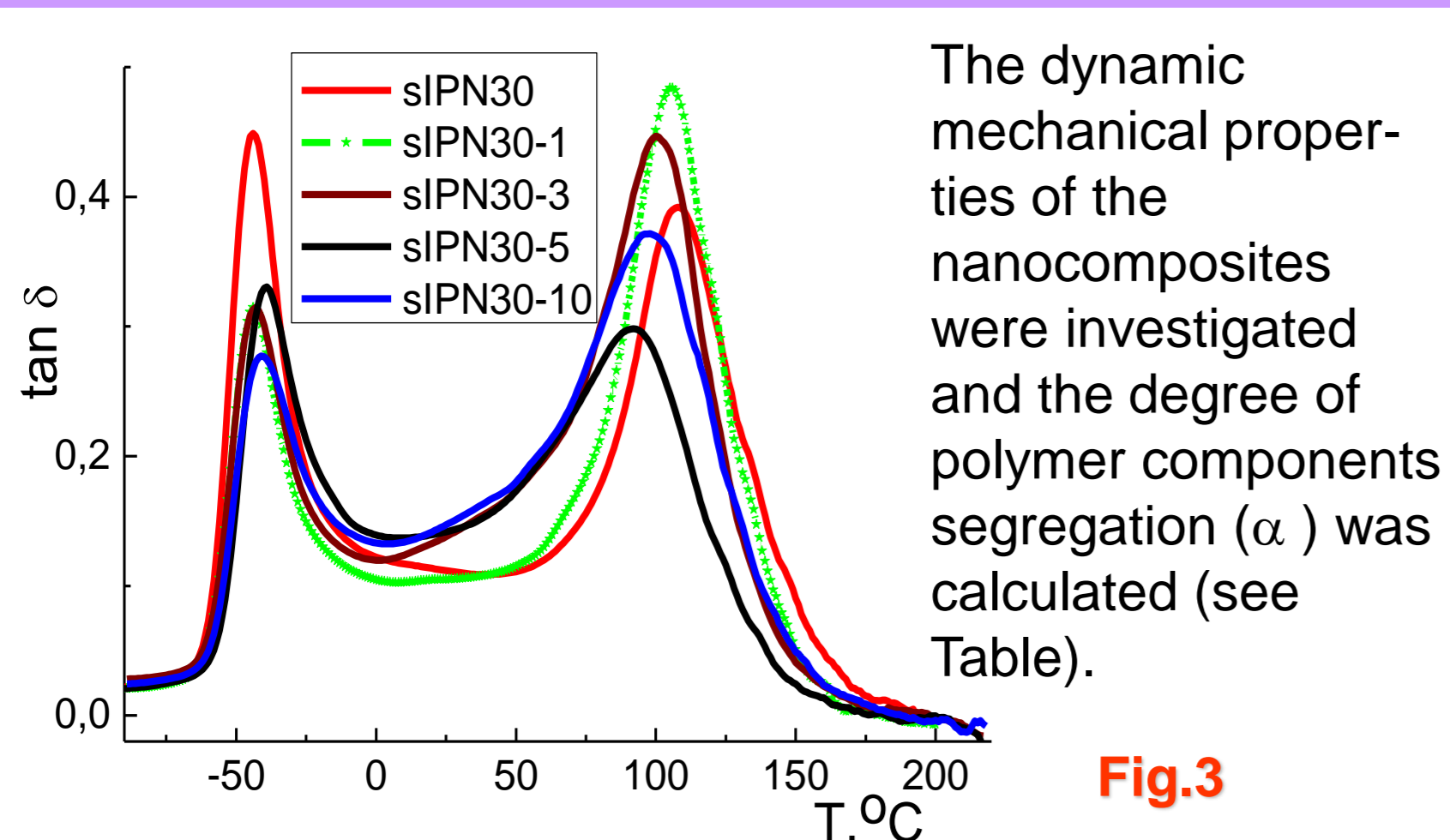


Fig.2

Increasing of POSS amount up to 5-10 wt.% leads to a change in free energy of polymer component's interaction, which becomes negative. These means that the increasing of POSS content to 5-10 wt.% lead to compatibilization in semi-IPNs.

Result & Discussion: DMA



The dynamic mechanical properties of the nanocomposites were investigated and the degree of polymer components segregation (α) was calculated (see Table).

Fig.3

It was shown that there are two peaks of $\tan \delta$ (PU and PHPMA) in the nanocomposites. The introduction of 1-3 wt.% of POSS lead to increasing of $\tan \delta$ peak of PHPMA (compared with native sIPN30) This means the further phase separation in semi-IPNs. Increasing of POSS content up to 5-10 wt.% leads to decreasing of $\tan \delta$ peaks of PHPMA, to their expansion and shift towards low temperatures. The increasing of "bridge" between the two peaks (PU and PHPMA) also occurs. This may indicate the formation of a significant part of interphase regions between the components of the semi-IPN. As a result the cooperative of segmental motion is lost. These is due to concentration of POSS particle not only in the PU nanodomain but also in the interphase region of semi-IPN. At the same time the degree of polymer components segregation (α) for these nanocomposites is significantly reduced (Table).

Conclusions

Investigation of vapor sorption properties of the nanocomposites have shown that more dense structure of the semi-IPN30 nanocomposites with high POSS content is formed compared to the native PU matrix;
The thermodynamic parameters calculations demonstrated that process of compatibilization took part in the semi-IPNs nanocomposites: the polymer components (PU and PHPMA) became thermodynamically compatible when the POSS content increases up to 5-10 wt.%.
By dynamic mechanical properties investigations and calculations have shown the decreasing of polymer component segregation degree (α) in the semi-IPN30 nanocomposites, especially when POSS content 5-10 wt%. This is due to allocation of POSS nanoparticles not only in the PU nanodomains but also in the interphase regions of semi-IPNs nanocomposites.

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