Ultragarso tyrimai PDMS/OLC kompozituose

Ultrasonic studies of onion-like carbons/polydimethysiloxane composites

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The integration of nanoparticles into a polymer matrix allows both properties from nanoparticles material and polymer to be combined, thus obtaining advanced polymer nanocomposites. In particular, additional nanoscale fillers such as carbon nanotubes or onion-like carbons, can be used to reinforce polymer matrices [1]. Their high specific surface area enables the formation of a large interphase in the composite and strong filler-matrix interactions. Earlier we exploited ultrasonic spectroscopy to study and evaluate relaxation processes that govern elastomer nano- composite elastic behaviour and to depict variation of these processes because of the change of the inorganic nanofiller content in polyurea elastomers [2,3]. For their elastic properties and low glass transition temperature poly-dimethysiloxane (PDMS) with onion-like carbons (OLCs) composites are similar to those of polyurea elastomer/ inorganic nanotube composites. Earlier we studied electric and dielectric properties of PDMS/OLC composites [4]. In this contribution we present temperature measurements of longitudinal ultrasonic velocity and attenuation in PDMS with OLCs nanofilers. The OLC nanocarbon dependant attenuation maxima together with velocity dispersion have been observed above the glass transition temperature. The addition of OLC nanocarbons resulted in the increase of ultrasonic velocity in low temperature region and the increase of attenuation at room temperature.

The OLC samples which we used to fabricate OLC/PDSM composites were prepared according procedure described in [3]. NDs with appropriative aggregate size were heated in vacuum (10^{-2} Torr) at 850 ^{o}C for 3 h providing the production of OLC with corresponding size of aggregates. It should be mentioned that primary OLC aggregates can form larger secondary aggregates which may be disintegrated in appropriate solvent or polymer matrix characterized by high wetting ability of graphene-like surface of OLC. The polydimethylsiloxane, Sylgard, was purchased from Dow-Corning as a two part material. When forming PDMS-OLC composites, an intermediate solvent was employed that served as a dispersion medium for the nanoparticles prior to mixing with the polymer matrix. The ultrasonic studies were carried out by means of automatic computer controlled pulse-echo ultrasonic system as described in [3]. The large dynamic range and large input ultrasonic power allowed the large ultrasonic attenuation values to be measured. The procedure of attenuation and velocity measurement in polymer composites was presented earlier [2].

The temperature dependencies of longitudinal ultrasonic attenuation at 10 MHz frequency for PDMS/OLC composites are shown in Fig. 1. All these graphs show that there are attenuation peaks characteristic of relaxation phenomena. Low temperature onset of the attenuation correlate with the glass transition temperature $T_g \approx 140 - 160$ K, known from earlier publications [4, 5]. Maxima of ultrasonic attenuation slightly shift towards higher temperatures after addition of OLC nanoinclusions and it is possibly related to the shift of T_g. The peak also widens with increasing of nanoparticle concentration.

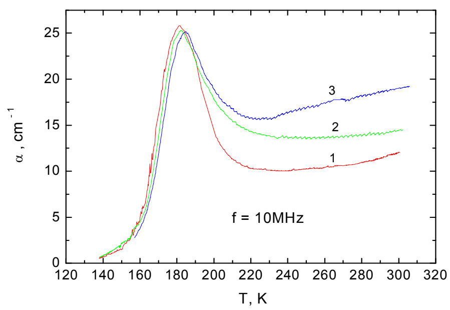

Fig. 1. Temperature dependencies of ultrasonic attenuation in composites PDMS /OLC: 1 – 0, 2 – 5, 3 – 10 wt% of OLC nanoinclusions

Keywords: ultrasonic attenuation; OLC nanoparticles; polymer nanocomposites

References

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