Ultragarsiniai polimerų kompozitų su MoS_2 ir OLC nanodalelėmis tyrimai

Ultrasonic studies of polymer composites with MoS_2 type and OLC nanoinclusions

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The integration of inorganic nanoparticles into a polymer matrix allows both properties from inorganic nanoparticles and polymer to be combined. Such polymer based nanocomposites have attracted increasing attention because of their unique properties emerging from the combination of organic and inorganic materials. In particular, nanoscale fillers such as carbon nanotubes or onion-like carbons (OLC) can be used to reinforce polymer matrices. Inorganic nanotubes, such as MoS_2 can be also used for fabrication of various composites based on polymer materials, because they exhibit a good homogeneity and solubility of the composite material. Composite materials made of polymers with functional nanofillers can become a perspective alternative for conventionally used materials in industry and science.

Ultrasonic waves as non-destructive testing technique is used for determination of elastic properties of polymers and polymer composites [1]. This method allows obtaining information about vibrating particles of a media and how it is influenced by addition of another material in the host lattice of polymer. Ultrasonic spectroscopy allows to observe and evaluate relaxation processes that govern nanocomposites elastic behaviour and to reveal variation of these processes because of the change of the filler concentration.

In this contribution we present the temperature measurements of longitudinal ultrasonic velocity and attenuation in two types of polymer composites with nanoinclusions: polyurea elastomers with MoS_2 nanotubes or $Mo_6S_2I_8$ nanowires and polydimethyl siloxane (PDMS) composites with onion-like carbons (OLC) or zinc oxide (ZnO).The temperature dependencies of longitudinal ultrasonic velocity and attenuation, of these nanocomposites based on nanoinclusions have been studied in wide temperature range including glass transitions. Ultrasonic measurements were carried out using automatic computer controlled pulse-echo ultrasonic system in 10-30 MHz frequency range. The system has large dynamic range and large input ultrasonic power, therefore the large ultrasonic attenuation values we are able to measure.

All investigated composite materials showed large ultrasonic attenuation maxima – of the order of $\alpha \approx$ 15-30 cm^{-1} for polyurea elastomers [2] and of the order of $\alpha \approx$ 20 - 25 cm^{-1} for PDMS-OLS composites at 10 MHz frequency – which appeared above the glass transition temperature T_g of the polyurea elastomer or PDMS polymer matrix. It was shown that the shape and position of these attenuation peaks was influenced by the presence of MoS_2 nanotubes in polyurea elastomers or OLC, ZnO nanoparticles in PDMS [3]. The increase of ultrasonic velocity with increase of nanoparticle concentration in investigated nanocomposites was observed showing the reinforce-ment of the polymer material. The significant increase of ultrasonic attenuation in PDMS with increase of OLS /ZnO concentration was observed at room temperature and such behavior can be attributed to ultrasound - nanoparticle interaction in polymer matrix.

Keywords: polymer composites, ultrasonic measure-ments, elastic properties, nanoinclusions, glass transitions .

References

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