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DEVELOPMENT AND CHARACTERIZATION OF ACRYLONITRILE-BUTADIENE-STYRENE BASED COMPOSITES WITH CARBON NANOTUBES FOR SMART 3D PRINTING APPLICATIONS

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ABSTRACT

The work is devoted to the development of carbon nanofillers modified acrylonitrile butadiene styrene copolymer (ABS) composites with multi-walled carbon nanotubes (CNTs). The method of manufacturing of ABS/CNT nanocomposites has been developed. Structure as well as elastic, dielectric and thermo-physical properties of ABS/CNT nanocomposites have been determined. It has been determined that addition of CNTs caused considerable increment of the modulus of elasticity, electrical conductivity and thermal conductivity of the material.

Keywords: nanocomposites, acrylonitrile butadiene styrene, multi-walled carbon nanotubes.

INTRODUCTION

ABS is popular engineering thermoplastics broadly used in the exponentially developing 3D printing area, particularly fused filament fabrication (FFF). Rapid development of the FFF market determines necessity for novel materials with improved technological properties (int al rheological, thermal, thermomechanical, adhesive, organoleptic) and enhanced performance characteristics such as mechanical strength, durability and other upon specific demands of the customers.

Development of polymer nanocomposites offer broad possibilities of tailoring the properties of the materials for the needs of advanced technologies in energetics, electronics, transport and other areas. Nanostructured carbon allotropes have been successfully used for modification of broad range of thermoplastic polymers to increase it mechanical, electrical, thermal and other properties (Tiwari, 2016) relevant for applications in sensors, thermoelectric devices, “shape memory” materials and other smart appliances.

Consequently, this research is devoted for investigation of elastic, dielectric and thermophysical properties of 3D printable ABS nanocomposites with multi-walled carbon nanotubes (MWCNTs) in a broad concentration range (0.5 - 20wt.%) for potential applications in smart devices.

RESULTS AND CONCLUSIONS

Storage and loss modules (*E’* and *E”* respectively) vs temperature relationships of ABS matrix and its nanocomposite at the highest content of CNTs are depicted in Fig. 1. *E’* and *E”* considerably increase along with rising the nanofiller content within the polymer matrix. Along with introduction of CNTs in the ABS matrix, glass transition temperatures of the polymer phases (both glass transition temperature of polystyrene moieties $T_{g\text{-}PS}$ as well as glass transition temperature of polybutadiene moieties $T_{g\text{-}PB}$) are shifted to higher temperatures testifying about stiffening effect of CNTs on the polymer macromolecules.

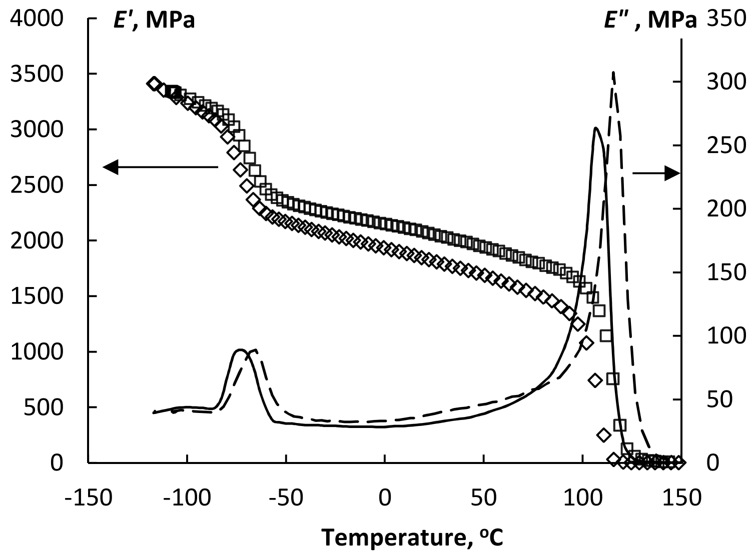

Fig. 1 - *E'(T)* and *E"(T)* relationships of ABS (◇, —) and ABS+20 wt.% CNT nanocomposite (ϒ, ---)

Addition of CNTs considerably affects also electrical conductivity (depending on frequency up to 6-14 orders at the maximum nanofiller content) and thermal conductivity (up to 130 % at the maximum nanofiller content) of the investigated ABS nanocomposites.

The present research shows that modification of ABS with MWCNTs allows considerably improve mechanical, electrical and thermal properties of the investigated composite materials for it potential application in 3D printable smart devices.

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