Structure and Properties of Fluoroplastic, Modified with Titanium Nanoparticles

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INTRODUCTION

Currently, one of the priority areas of materials science is the creation of polymeric composite materials (PCM), including compounds with nanoscale fillers that have more advanced features and improved performance. Polytetrafluoroethylene (PTFE) is promising composite matrix because of its properties: chemical and thermal resistance, low friction coefficient, high hydrophobicity and others.At the same time, insolubility and high melt viscosity of PTFE led to difficulties of obtaining homogeneous composites without aggregation of filler particles, which largely determines the properties of PCM.

There are several technological methods to obtain PTFE-based nanocomposites [1, 2]. Pyrolysis of PTFE mixture and ammonium fluoride produces ultrafine composite powder from PTFE and inorganic fluorides $(NH_4)_2TiF_6$. The molecular components mixture processing of condensed ammonia water and subsequent dissolution of ammonium fluoride NH_4F allows to obtain a composite mixture of PTFE and TiO_2. Titanium exists in obtained fluoro-organic powder, and it was called titanium fluoro-organic powder (TiFT) [3, 4].

TFP composites was used as additives to PTFE suspension powder, allowing to adjust downward the filler concentration in the samples.

The practical applicability of PCM is largely determined by their properties, which formed by their structure. This paper presents studies of structure and properties of PTFE-based composites with micro and nanoscale fillers containing titanium (TiFP) and previously studied cobalt (CoFP) [5] and silicon compound (SiFP).

Suspension PTFE (GOST 10007-80) was used as a polymer matrix. Composites were prepared in mechanical mixing mode, then tabletting and sintering with TiFP concentrations of 0.05; 0.1; 0.5; 1 and 5 wt. parts to 100 wt. parts of PTFE.

Sample preparation modes: mixing in electromagnetic mixer for 30 minutes with rotation frequency of 1000 r/min. Tableting in a plunger mold with pressure of 100 MPa for 60 seconds. Sintering at T=638-643K for 60 minutes without excessive pressure. Received block composites are called PTFE+TiFP.

X-RAY DIFFRACTION ANALYSIS

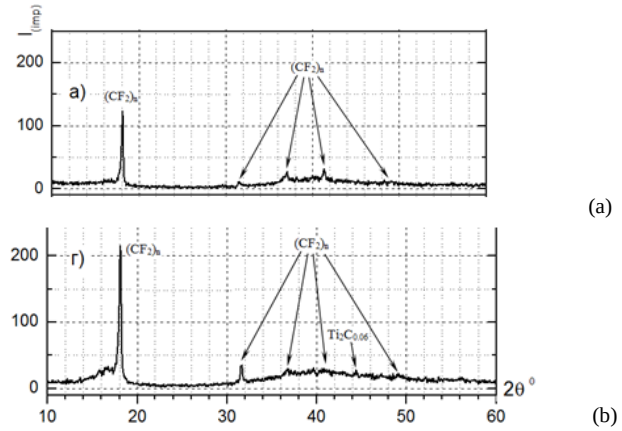

FIGURE 1. Radiographs of virgin PTFE (a) and PTFE+5wt.parts of TiFP (b).

PROPERTIES OF COMPOSITES

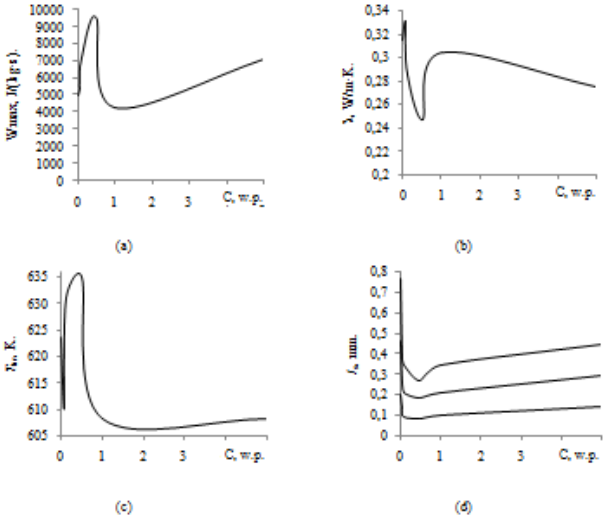

FIGURE 2. The concentration dependences of the maximum energy absorption rate W_{max} obtained on DSC-2 (a), the thermal conductivity λ (b) deformation heat resistance T_{hr} (c), and the size wear I_S (e) of the polymer composite PTFE + TiFP from the concentration of TiFP filler. Abrasive wear time is 20 min (1), 40 min (2), 60 min (3); counterface speed 12 rev/min; pressing force was 0.5 kg.

STUDY OF DIELECTRIC PERMITTIVITY

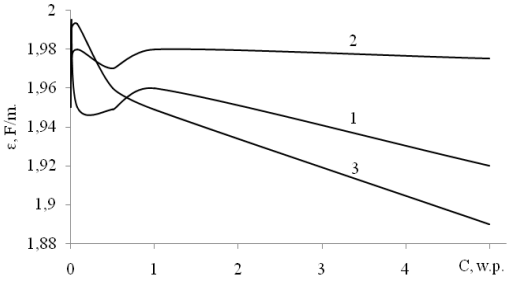

FIGURE 3. The concentration dependence of the dielectric constant ε of the composite samples PTFE+SiFP (1), PTFE+TiFP (2), PTFE+CoFP (3) [5], from the concentration of the modifying additives (SiFP, TiFP, CoFP) in 100 Hz to 1 MHz frequency range.

CONCLUSIONS

This work reveal the possibility of controlling the structure and properties of PTFE-based polymer composites with small additives concentrations of dispersed nanocomposites, based on ultrafine PTFE and titanium-containing nanoparticles. The developed technology allows to extend the known method of organic and inorganic materials alloying to the production technology of block molecular composite polymers based on polytetrafluoroethylene.

The composite properties depend on the concentration of TiFP nanofillers, and production technology of molecular composites.

PTFE+TiFP block molecular composites exceed 25º in comparison with the original PTFE in deformation heat resistance and 2-4 times in durability. The maximum rate for PTFE+TiFP system properties is achieved with about 0.5 wt. parts.