The effect of filler surface chemistry on the tribology properties of nanodiamond/polytetrafluroethylene composites

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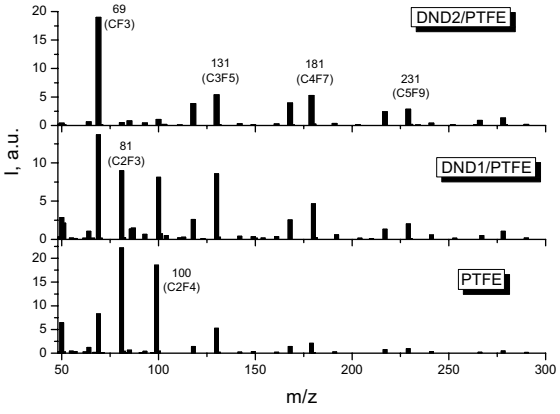
Detonation nanodiamond (DND) is very attractive nanoscale filler of polymers. The commercially available DND have quite different surface chemistry depending on the details of synthesis technology. The question of how the DND surface chemistry can affect the properties of polymer composites remains open.

We have studied the tribological behavior of polytetrafluoroethylene (PTFE) filled with DND of different types both in as received and chemically modified forms. The DND surface chemistry was characterized by IR-spectroscopy and thermodesoption mass spectrometry. DND(1-5%)/PTFE composites were prepared by mechanical mixing, compressing molding and sintering at 380°C. The composites samples were characterized by differential scanning calorimetry, scanning electron microscopy and wear/friction tests.

Experimental results showed that the wear rate reduction, caused by DND filler, depends strongly on the oxidation state of nanodiamond surface. The oxygenated groups at DND surface were found to influence the crystallinity of polymer matrix as well. These results indicate that DND particles in PTFE composites play not only the role of "mechanical" impurities but they also could interact chemically with PTFE matrix usually considered as "chemically inert". This suggestion was confirmed by the observed differences in mass spectrometric compositions of volatiles released during sintering of PTFE filled with DND of different surface chemistry (see Figure).



The obtained results give for the first time the evidences of: 1) the chemical interaction of DND filler with PTFE matrix during sintering procedure; 2) the dependence of this interaction on surface chemistry of DND; and 3) the influence of this interaction on the properties of DND/PTFE composites.

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