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Electron emission of the carbon nanotube-reinforced epoxy surface nano layer towards detection of its destruction induced by elastic deformation

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A loaded material surface that interrupts a continuum is a mechanical stress concentrator. Therefore atomic/molecular couples situated at the surface nanolayer could be overloaded and destructed. These strongly result the material exploiting capacity under chemical and microbiological environment conditions. Dilatation and destruction of the couples alters the surface potential barrier (PB) that an electron excited by an external source is able to leave. In this respect the electron emission (EE) of the loaded material is able to indicate its overloading/destruction.

A carbon nanotube-reinforced epoxy composite (NREC) that is characterized with high strength-to-weight ratio has a wide perspective for aerospace, automotive, civil engineering, etc technical applications. However, a knowledge about NREC surface processes induced by mechanical loading that overload/destroy atomic/molecular couples is very poor.

The research is directed to *in situ* explore EE induced by axial loading of NREC. The specimens prepared for the central axial loading as typically were loaded at the vacuum 10^{-4} Pa. The specimens had a concentration of the carbon nanotubes (CNT) in a range 0…1.0%. The EE was detected alongside with loading. The EE was excited by the ultraviolet photons. Their energy was selected to be close to the PB. As the result an energy of the exited electrons was around 5eV and therefore they emitted just from the NREC surface nanolayer with a thickness ~ 10 nm. A secondary electron multiplier was to detect electrons, their current being was around $> 10^{-17}$ …10^{-16} A.

The experiments demonstrated that EE depended nonlinearly on the elastic strain extended from 0 to 2% . Several maxima of EE current were detected that evidenced about excitation/damaging of surface atomic-molecular couples. The first maximum displayed at ~ 0.3 % of strain and was identified as delivered from the epoxy binder. The EE current decreased around 10 times with raising of the CNT concentration in the above range. This indicated increasing of PB, the latter relating to the elasticity module. Growth of CNT concentration increased elasticity module and induced the EE maximum at ~ 1.2% of strain (~60 % of the strength).

The results achieved are in favor that EE is the effective instrument to explore NREC surface nano layer destruction induced by the elastic deformation.

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Biography:

Prof. Yuri Dekhtyar has the expertise to functionalize and characterize nanoobjects and nanostructured materials. He is the leader in prethreshold electron and exoelectron spectroscopy. Has around 450 publications, leaded a number of the international and national projects. Head of the Institute of Biomedical Engineering and Nanotechnologies of the Riga Technical University, Latvia; Latvian State Prize winner; full member of the of the Latvian Academy of Sciences; member of national and international societies . Organized several international conferences, delivered a number of the invited lectures at the meetings and universities around the world. Contributed to the education of hundreds BSc, MSc students both at the home and internationally hosting universities. Supervised a number of PhD students.