CNT-Pd-C nanocomposite films for terahertz applications

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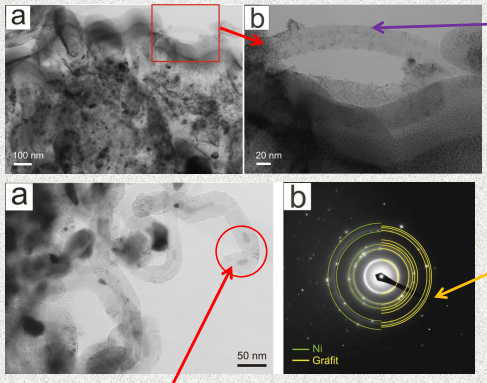
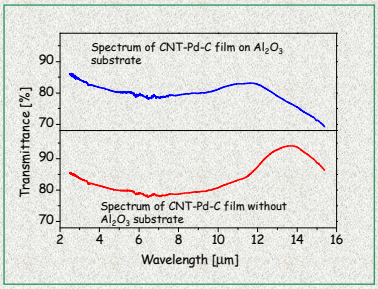
The aim of this paper is to investigate the ability of nanocomposite films containing metalized carbon nanotubes (CNT) to the generation and detection of electromagnetic radiation in the MIR /THz range (100 - 0.3 THz). These films could find many applications including medical imaging, security systems, telecommunications, spectroscopy and astronomy.
In recent research indicates the possibility of generation and detection of MIR/THz type of radiation using single-wall carbon nanotubes. Recently, it was shown that multiwall carbon nanotubes - polimer composite material can be appplied as THz radiation emitter [1]. Terahertz measurements were done by the authors by two independent ways: firstly, by the Fourier spectrometer and, secondary, on the Novosibirsk terahertz free electron laser (THz NFEL).
In this presentation we propose new nanocomposite material which is built of MWCNT's (with Ni nanograins) film covered with amorphous carbon and nanograins of palladium . These films have semi metallic character and their resistivity is about few hundreds of Ohm. Characterisation of the material was performed with SEM, TEM, Raman and FTIR methods.

TEM images of these films showed that Ni nanograins are placed inside of nanotube while Pd nanograins are found on the surface of nanotube



FTIR spectra



The top spectrum refers to CNT-Pd-C film deposited on alundum substrate and the bottom spectum to CNT-Pd-C film after alundum substrate background subtracting. The presented spectra show that the films are transparent in far infrared region. The films transmittance decreases at the end of the spectral range. These films require further study in the MIR region.

Conclusions:

In summary, we have demonstrated that the CNT-Pd-Ni nanocomposite films possesses:

- Low resistance of a row of 100 Ohm
- very high transmittance in the infrared part of the spectrum (2-15 mm)
- CNT's that are component of films could have semiconducting

The transmittance of these films decreases for the longest wave length in this region and it should be studied an appearance in MIR.

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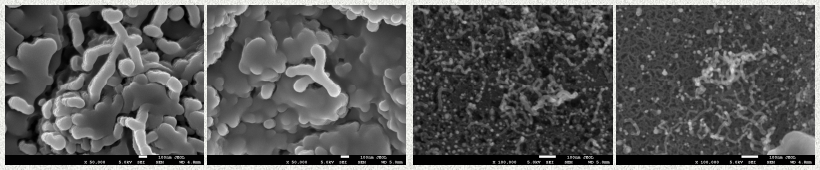
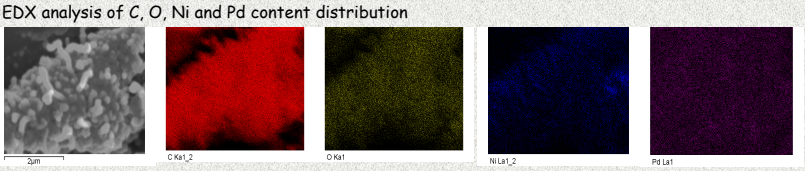
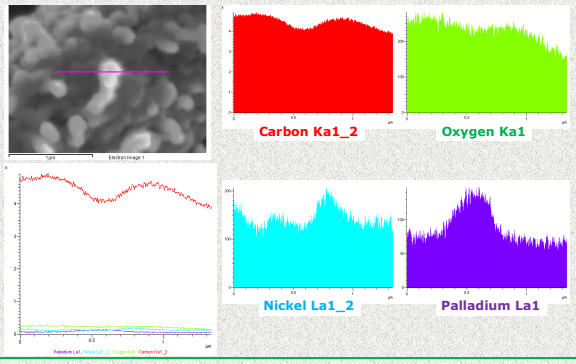
Our films were prepared by mixed PVD/CVD/PVD methods. Firstly nanocomposite film built of Ni and carbonaceous nanograins was deposited on a substrate by PVD method. Then, in CVD pyrolitic method a film of multiwall carbon nanotubes were obtained. Finally, nanograins of Pd and fullerenes were deposited on such film also by PVD.
Resulting, we obtained many kind of fillms shown in SEM images below.



EDX analysis of C, O, Ni and Pd content distribution

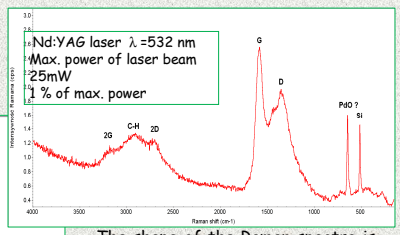


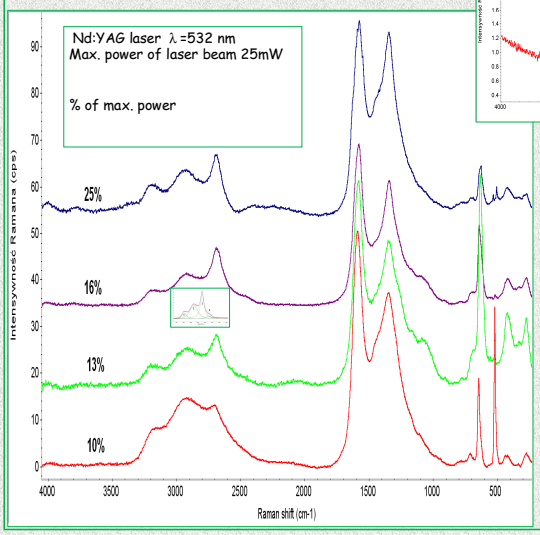
EDX analysis of C, O, Ni and Pd content distribution in a single nanotube



Our films possesses low resistance of order 100 Ohm, what could be connected to a Pd nanograins palced all over each nanotube

Raman spectra of these films show following bands:
- D band in the first and the second row
- G band in the first and yhe second row
- C-H vibration attributed band





The shape of the Raman spectra is characteristic for the graphite-like amorphous carbon [2-6]. The D and G bands characteristic of disordered graphite was observed in the 900 - 2000 cm^{-1} region. In the range of 2500 - 3500 cm^{-1} three overlaid bands can be observed which are identified as 2G and 2D overtones and the band related to the presence of C-H bonds [4]. The Lorentzian shape of G band could be connected to semiconducting character of nanotubes

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