

## Morphology and Vibrational Structure of Multi-Wall Carbon Nanotubes

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In recent time multi-wall carbon nanotubes (MWCNs) were used for organic bulk heterojunction structure [1]. The preparation of controlled morphology in which uniform distribution of MWCNs in the whole bulk of films is necessary. The MWCNs prefer to form agglomerates to homogenic distribution. As the diameter of MWCNs is less than the film thickness of organic photovoltaic cells, the MWCNs planar location can leads to surface conductivity. Fig. 1, 2 show SEM images of as-prepared MWCNs and made by Langmuir–Blodgett (LB) after ultrasonic treatment in chloroform solution (2 hours) 0,1 mg/ml, respectively. The parameters of ultrasonic treatment: frequency 40 kHz, power 50 watt and volume 0.5 L. The transfer of film on glass substrate was due to horizontal lifting in LB method.

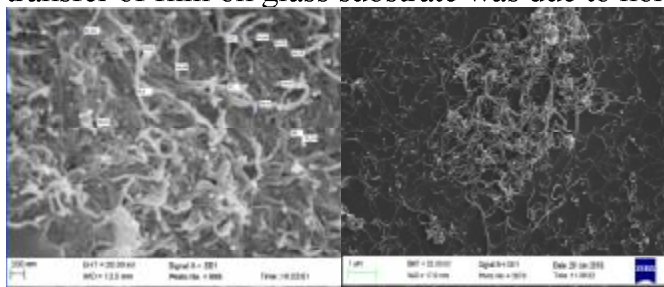


Fig. 1. SEM images of as-prepared MWCNs.

Fig.2. SEM images of MWCNs made by LB method.

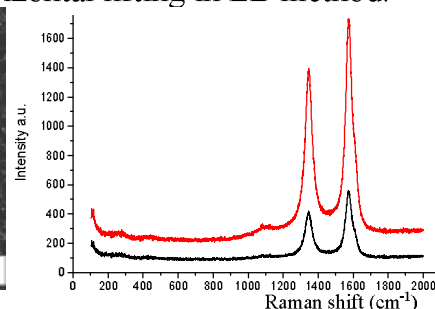


Fig.3. Raman scattering of as-prepared MWCNs (black curve) and MWCNs made by LB method (red curve).

The mean diameters of MWCNs after 2 hours of ultrasonic treatment is 54.28 nm, which is not very different from as-prepared (55,82 nm). Also, there is no difference of their length that average is about 3.5  $\mu\text{m}$  before and after ultrasonic treatment. There are G, D modes in Raman spectrum of MWCNs at frequencies 1346 and 1574  $\text{cm}^{-1}$ , respectively. As shown in Fig. 3 shows the Raman spectrum of MWCNs. The position of G, D modes of both before and after treatment identical to within  $\text{cm}^{-1}$ . The  $G/D$  ratio remains almost unchanged. Based on experimental results we can say that MWCNs before and after ultrasonic treatment stay almost the same structure. LB method allows to obtain a monolayer MWCNs films.

1. J. Arranz-Andre's, W. J. Blau. Enhanced device performance using different carbon nanotube types in polymer photovoltaic devices // Carbon.– 2008. – 46, 2067.