Model of anisotropy of deformed polymer carbon nanotube based composites in Ka-band (26-37 GHz)

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Theoretical model of the deformation influence on electromagnetic response of carbon nanotube (CNT) based polymer composites is presented. Anisotropy of dielectric permittivity was observed and theoretically modeled in frequency range 26-37 GHz (Ka-band).

Extremely high aspect ratio and cylindrical structure of CNT causes anisotropy of their mechanical and electromagnetic properties. For instance, polarizability of isolated CNT in axial direction is much greater than polarizability in perpendicular direction. Therefore in the case, when CNT are oriented in composite, we can observe the anisotropy of electromagnetic properties. Stretching deformation was used for orientation of CNT in polymer matrix (PMMA). In this case electromagnetic response of composite depends on direction of electric-field vector of scattered electromagnetic wave. The change of nanotube orientation during stretch deformation of composite was simulated. The distribution function of carbon nanotubes in deformed composite material was analytically derived and used for calculation of complex dielectric permittivity tensor of composite material (see Fig.).

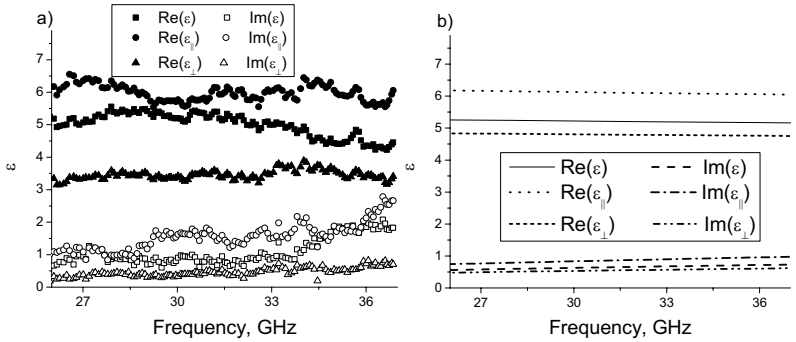

Figure: (a)Experimental data of dielectric permittivity of deformed CNT/PMMA composite. (b) Calculated permittivity of deformed CNT/PMMA composite (ε - permittivity of not deformed composite, $\varepsilon\perp=\varepsilon_x=\varepsilon_z$, $\varepsilon_{||}=\varepsilon_y$ – diagonal components of dielectric permittivity tensor of deformed along *y*-axis composite).

This research was partially supported by the RFBR Project No. 10-03-90901-mob-sng-st, the BRFBR Projects No. F10R-002 and No. F10CO-020, EU FP7 under Project FP7-266529 BY-NanoERA, and ISTC Project No. B-1708.