Scaling reciprocal of nanotubes aggregation degree in aqueous suspensions against nonlinear optical properties of the systems

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Abstract—Nonlinear optical limiting of suspensions of single-wall carbon nanotubes with varied degree of debundling and various stabilizing surfactants has been studied.

Keywords—single-wall carbon nanotubes; non-linear optical limiting; amphiphile

We re-visit an issue of the bundled material impact upon the non-linear optical power limiting (OPL) in the fluid systems containing single-wall carbon nanotubes (SWCNTs). To this end, we processed a batch of aqueous SWCNT suspensions stabilized with a set of surfactants: sodium dodecylsulfate (SDS), sodium dodecylbenzenesulfonate (SDBS) and sodium cholate. Varied regimes of mechanical development were applied. Altering the ultrasound duration let us get varied degree of nanotubes association stabilized by a variety of amphiphile micro-environments. We got a protocol of suspensions’ degree of bundling by Cryo-TEM technique alongside Raman and luminescence spectroscopy [1, 2].

In first place, systems having similarly aggregated nanotubes (ranging from predominantly isolated to highly bundled) but varied nature of micro-environment (and thereby various wavelengths of plasmonic resonance) were juxtaposed regarding importance of scattering the energy of the optically photo-excited electron structure on the p-electron plasmon. In all of the suspensions processed we undertook subtraction of the plasmonic increment into the net optical absorption and reduced the nano-carbon concentrations to the same value. All the systems having constant association of carbon material exhibited insignificant differences of the OPL parameters (limiting threshold and limiting factor). We conclude very vs. predominant (in terms of time) scattering on phonons of the nanotubes carbon carcass.

Secondly, the OPL measurements in all of the materials gotten showed superior characteristics of the OPL in suspensions with higher degrees of SWCNTs association irrespective of the micro-environment identity.

References