Solubility of functionalized carbon nanofibers in different aqueous media

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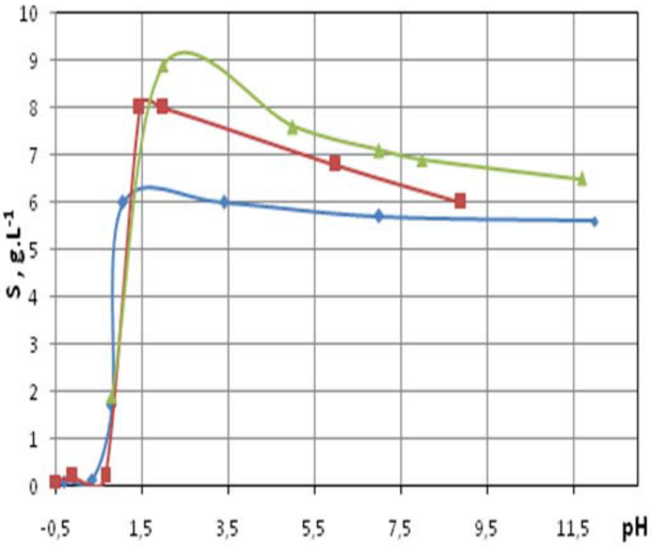
Carbon nanofibers (CNF) represents a variety of filamentous carbon nanomaterial and inherently are similar to multi-walled carbon nanotubes. Interaction with concentrated HNO_3 or mixture with concentrated H_2SO_4 leads to oxidation of CNFs, formation of surface carboxyl, hydroxyl, carbonyl and other oxygen-containing functional groups. The functionalization allows to form stable dispersion of CNFs in different solvents.

In our work we used functionalized CNFs with a solubility (concentration in aqueous dispersion) from 1.9 to 8.7 g L^{-1} at pH = 6–7. To measure the solubility at different pH value (in a range from –1 to 12) HCl or NaOH were added to the dispersions.



As it is shown on the presented graph, sharp change of solubility at pH = 1.0 is evident for all studied samples. The difference in solubility is due to the formation of hydrogen bonds between carboxyl groups, which are formed at pH < 1. Bonding of the adjacent CNFs leads to aggregation, constitutive growth of mean molecular mass and precipitation of the formed particles. In the area of pH > 1 deprotonation of carboxyl group and decomposition of the aggregates are evident.

The deprotonation can proceed not only at pH > 1. Addition of aqueous solutions of some salts to deposit of carboxylated CNFs also causes decomposition of the aggregates and solubilization of CNFs even at pH < 1. The mechanism of this process is connected to substitution of protons by metals due to ion exchange sorption. Such behavior was registered for $ZrOCl_2$ and $ZrOSO_4$, but was not observed for Ni and Cu salts.