Significantly increased solubility of carbon nanotubes in superacid by oxidation and their assembly into high-performance fibers

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Carbon nanotubes (CNTs) haves superb mechanical, electrical, and thermal properties as well as high flexibility. Among the various methods to spin CNT fibers, wet spinning is regarded to be the most promising method because it allows high alignment and density. The single biggest challenge in wet spinning of CNT fibers is the difficulty in dissolving CNTs in a solvent. Since it was reported that chlorosulfonic acid (CSA) is thermodynamic solvent for CNTs, wet spinning of CNT fibers using CSA has been developed rapidly. The prerequisite for dissolution is known to be highly crystalline structure of CNTs, but this is not enough to describe the solubility of CNTs in CSA. We found that not all CNTs are dissolved by CSA even though they are highly crystalline. In this study, we demonstrate that the incorporation of small amounts of oxygen into CNTs significantly increases the solubility of CNTs in CSA. Based on this understanding, we established an optimal purification process to prepare liquid crystal dope of CNTs with high concentration in CSA. As a result, CNT fiber with high mechanical strength and electrical conductivity were synthesized by wet spinning method.