Simple Spectrometric Determination of Iron and Aluminum Contents in Carbon Nanotubes

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In order to bring the excellence material Carbon Nanotubes (CNTs) to application level, the mass production is carried with involving combination of Iron (Fe) catalysts on alumina support as the industrial requisition. However, the presence of these metal catalysts has been a barrier in areas requiring high-purity CNTs, such as lithium batteries [1] or semiconductor nanocomposites for high-voltage power cables [2]. Metallic ion species can deteriorate their electrochemical performances and cause breakdown in cable. Therefore, many synthetic techniques or purification processes have been developed to improve the purity of CNTs, which requires analytical tools or methods to measure extremely low concentration of metallic impurities remaining in CNTs. This study developed facile method to determine the amounts of Fe catalyst and alumina support by utilize the easily available UV-visible spectroscopy. Fe and Al were extracted by refluxing CNTs in an acidic solution with of temperature, reflux time, and solvent optimization. By TEM, metallic particles were observed to be encased in graphitic layers which potentially prevent the extraction. Therefore, ash residue was obtained by burning CNTs up to 900°C and extracted with reflux. Fe and Al ions in the solution are able to form complex with 1,10-phenanthroline and Eriochrome Cyanine R produce red-color and pink-color, respectively, whose intensities are proportional to the concentration of each element in the solution. Series of standard solutions were designed to build the calibration equation. The effects of coexisting Fe and Al in CNTs on quantitative analysis were also elucidated by using the solutions of pre-determined compositions. Our facile quantitative analysis method of Fe and Al in CNTs by using UV-Vis spectroscopy has been validated by inductively coupled plasma atomic emission spectroscopy (ICP-AES).