A Novel Analytical Method for Quantifying Metallic Impurities in Carbon Nanotubes by Using ICP-OES

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Many applications have been proposed for carbon nanotubes (CNTs) that touch a wide variety of technological arenas, from the automotive and aeronautical industries to biomedicine and energy storage devices. CNTs synthesis methods rely on the use of catalysts with common transition metals. These transition metals, even at low concentration levels, can interfere with different applications of the CNTs. Therefore, development of a reliable quantitative quality control method for the elemental composition of as-produced CNTs has become a necessity. Ideally, given the expected production volume of this material, these should be with low detection limit, sensitive, low-cost and fast. Inductively coupled plasma optical emission spectrometry (ICP-OES) is the ideal analytical technique that fit with such requirements. This project developed a unique sample preparation method based on dry ashing to accurately quantify the metal impurities present on a single-walled carbon nanotube (SWCNT) sample using ICP-OES. The sample was analyzed with Instrumental Neutron Activation Analysis (INAA). The INAA elemental concentrations serve as the true values for the present method development. Eight different sample preparation methods were tested wherein the combustion of SWCNT took place at either 500 oC or 550 oC in normal air. Also, the type and concentration of the acid used to recover the metal elements from the resulting ashes was varied. Overall, dry ashing at 500 oC, followed by extraction with diluted acid nitric at 10%, provided the recovery of more than 90% for Ce, Co and Mo. ICP-OES has proved to be a reliable, fast and low cost alternative for INAA which will facilitate the manufacturing of CNTs making it easier to implement them in more fields.