# Development of a process and an apparatus for the synthesize of carbon nanotubes from coconut shells

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# Abstract

Carbon nanotubes (CNTs) have been identified as the most promising material at the nanoscale due to their unique mechanical, electrical, magnetic, optical and thermal properties. As a result, there are wide variety of potential applications of CNT ranging from biomedicine to industry. Due to its plethora of applications, it is also known as the twenty-first century material. CNTs are sheets of graphene that are rolled into tubes. The well-known synthetic methods of carbon nanotubes include arc-discharge, laser ablation and chemical vapour deposition (CVD). Many different hydrocarbon sources are used to synthesize CNTs. Coconut shells are one of the waste materials in Sri Lanka and main use of this waste is to produce activated carbon. During the process of making activated carbon tons of gaseous hydrocarbons are released to the atmosphere. To date the gaseous waste of coconut shells have never been used to synthesize carbon nanotubes. Therefore, the main objective of this study was to design and establish an apparatus to synthesize CNT from coconut shells. For this purpose, a new home-made apparatus was designed for the synthesis of CNTs. Charcoal is collected from the pyrolysis chamber and liquid is separated from hydrocarbon gas by condensing. Charcoal and phenolic liquids can be used for production of activated carbon and biofuels respectively. The gases produced in the pyrolysis were used in the CVD apparatus to synthesize CNTs. In the process of this CVD method the hydrocarbon gas was passed through the tube furnace containing different catalyst such as Ni, Fe and Co at 750 °C under argon atmosphere. The effect of catalyst, matrices and the temperature on the formation of CNT from coconut shells were also investigated. This method resulted in giving various sizes of multi walled carbon nanotubes under different catalytic conditions. Synthesized CNTs were characterized using thermal methods, scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The diameter of CNT synthesized using the iron catalyst with MgO support was found to be in the range of 35 to 70 nm in diameter and length determined to be in micrometer range. In addition, carbon fibers with diameter of 200 nm was found with the iron catalyst. Micrographs also indicated that the synthesized carbon nano tubes are multiwalled, nonlinear tubes and contain branches, coiled structures with the formation of about 20 walls. The smallest CNT networks were resulted using the nickel catalyst on MgO support matrix. A narrow distribution (11-14 nm) of CNT using the catalyst was an indicative of formation of few walls compared to the iron catalyst. The formation of CNT in the presence of Ni catalyst at different temperatures proved that the higher temperature leads to the formation of crystalline, lengthy and uniform sized nanotubes. The use of cobalt catalysts resulted in agglomerated carbon fibers. The Use of nickel catalyst with silica as the catalyst support produced CNTs with an average diameter of 34 nm. This is considerably larger in comparison to the CNTs produced by the nickel catalyst with MgO support where average diameter was 12 nm. This study revealed the possibility of forming CNTs from coconut shells. Therefore, this opened up the path to convert waste hydrocarbons produce from activated carbon industries to synthesize one of the very important materials, CNT, to be used in many industries. Other major advantage of this finding is that this process also help to reduce environmental pollution by converting the waste gas into a wonder material.