HIGH PRODUCT YIELD IN A NARROW COLUMN CONFIGURATION OF CARBON NANOTUBES: A PATHWAY FOR NANOSYNTHETIC MACHINE

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The functionalized multiwalled carbon nanotubes have been used in a narrow column configuration of (3.1 cm X 0.2 cm) such that the reactants are in contact with the carbon nanotubes before flowing out into the receiver. The column was examined for the flow with acetonitrile or acetone before loading it with the reactants. The products of the reaction were collected and examined by GC/MS and UV-VIS absorption spectrophotometry. In the first set of experiments, a mixture of aniline and hydrogen peroxide (1:1) was fed into the column. The fraction that came out of the column in about 8 minutes was red in color. The GC/MS analysis showed 100% azobenzene as the sole product. Table 1 gives the mass spectral fragmentation details for identification purposes. The UV-VIS absorption spectrum showed maxima at 347 and 425 nm, which is characteristic feature of azobenzene. The color of the solution stayed red for several weeks showing no further reactions were taking place in the solution. This is probably the first instance of catalyzed oxidation of aniline producing a single product in 100% yield at room temperature. To understand the mechanism, experiments were carried out in degassed and oxygen saturated solutions of the above mixture. The results suggest that hydrogen peroxide is directly involved in the oxidation.

Table 1: GC/MS Fragmentation Data

Species oxidized	**Mass Nos.**
Aniline[a]	28,77,93,105,152,182
p-Toluidine[a]	28,92,120,210
N-Methylamine[b]	15,28,43,58

a: Solvent: acetonitrile b: Acetone

The oxidation of p-toluidine and N-methylamine were also carried out in the column configuration of functionalized multiwalled carbon nanotubes. In all cases the azo product is distinctly observed. With N-methylamine, the starting material is a solution (Aldrich) as it is a gas with considerable solubility in different solvents. Hence the mass spectral features contain a large number of fragments arising from the solvent, which need to be removed before identifying the azomethane. The sole yield of one single product could not be established in this case.

The narrow column configuration of the functionalized carbon nanotubes produces results, which are distinctly different from those suspended in the medium[1,2]. In the latter situation, the products generated outside the carbon nanotubes mix up with the ones occurring on/inside the carbon nanotubes. The column configuration reduces this contribution demonstrating the catalysis of the carbon nanotubes. This catalysis might be occurring due to the confinement of the intermediate species of the oxidation due to the availability of flexible electron densities at some of the carbon atoms in the functionalized carbon nanotubes. The prospects of constructing a nano synthetic machine which will give 100% yield of one sole product appears to be feasible with the functionalized carbon nanotubes.

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2. M. Croston, J. Langston, R. Sangoi and K.S.V. Santhanam, J. Nanoscience, 2002 (in press).