Controlled Synthesis of Multiwalled Carbon Nanotubes for CO_2 Adsorption Application

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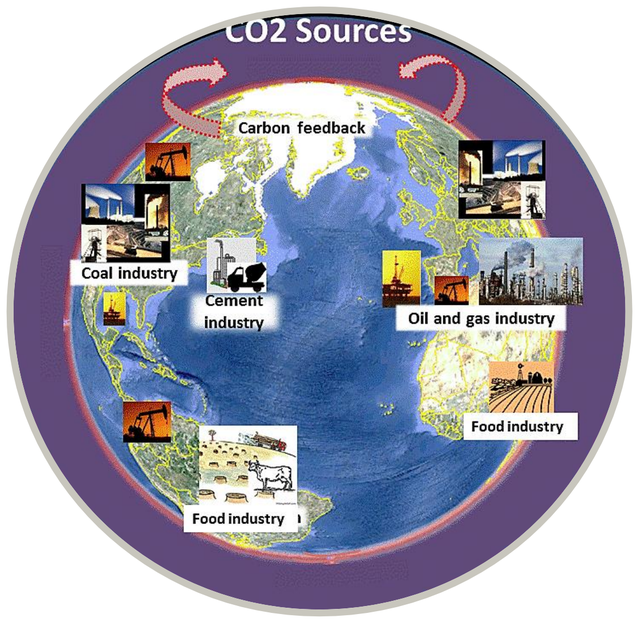
ABSTRACT

Highly crystalline MWCNTs were produced in bulk and functionalized with H_2SO_4/HNO_3 and APTS for their potential application in CO_2 adsorption. Oxidation and functionalization of nanotubes and consequently their adsorption capacity were purely based on degree of crystallization. The breakthrough curves revealed higher CO_2 adsorption capacity of modified MWCNTs than the pristine ones. High CO_2 uptake of 129 cm3/g was achieved with fully functionalized MWCNTs.

RESEARCH BACKGROUND

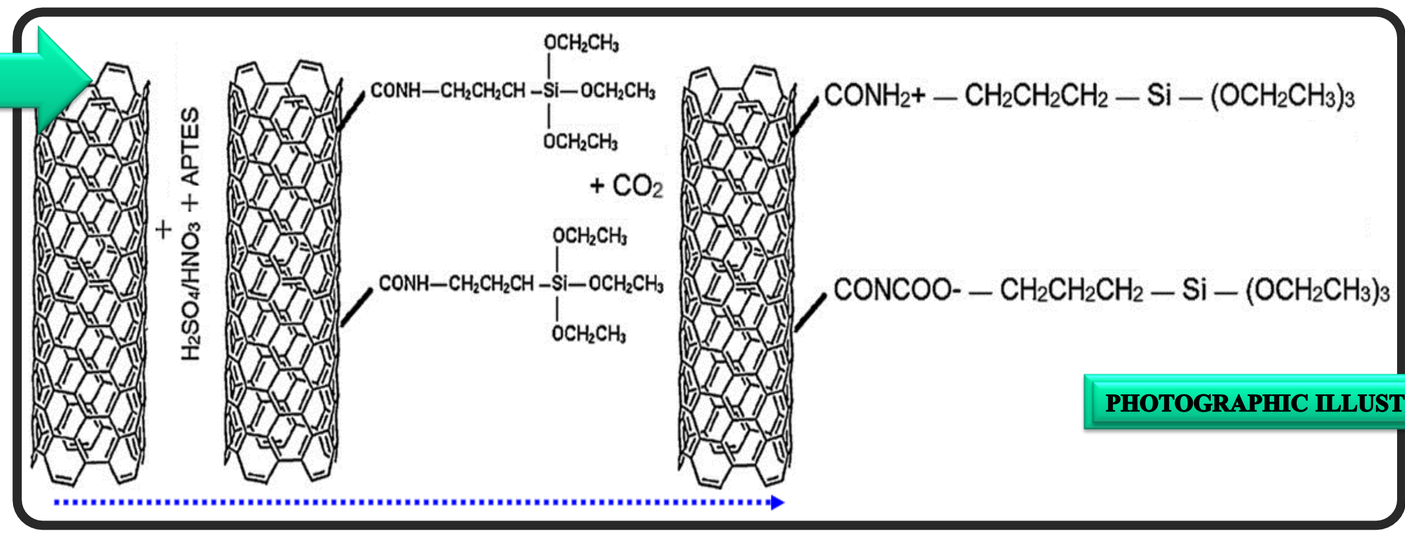
Green-house effect is considered as one of the most important environmental issues that humanity faces. CO_2 is acknowledged as the most conspicuous greenhouse gas, with its atmospheric concentration being continuously increased. The high amounts of CO_2 gas increasingly dispersed in the atmosphere have motivated academia and industry to develop new technologies for CO_2 sequestration and storage. This study was aimed at development of Carbon Nanotubes based CO_2 adsorbents.



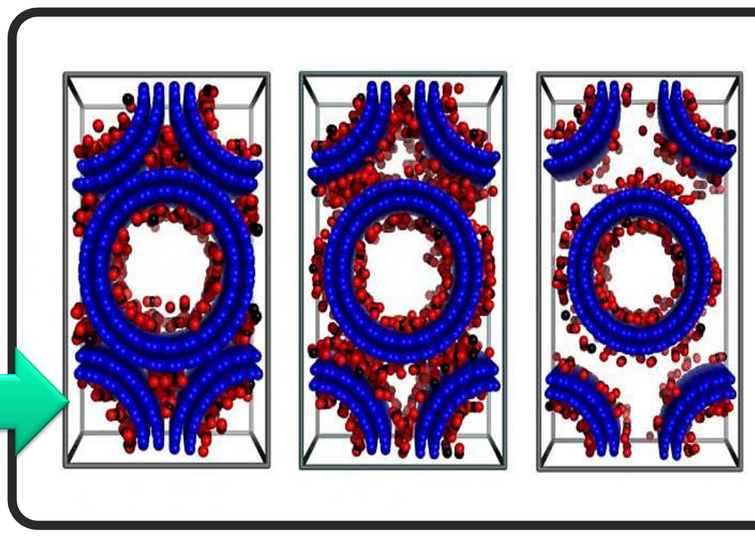
RESEARCHPROBLEM & OBJECTIVES

- **The past research efforts have not been translated into high percent yield of nanotubes with well-defined structures, favorable for easy functionalization and high CO_2 adsorption. In line with this, degree of functionalization and inter-tube spacing integration for CO_2 adsorption have not been fully understood. Therefore a thorough study is imperatively required to look into the highlighted aspects.**
- **The presented work was aimed at production of good percent yield of highly crystalline MWCNTs and their functionalization to achieve better CO_2 adsorption capacity.**

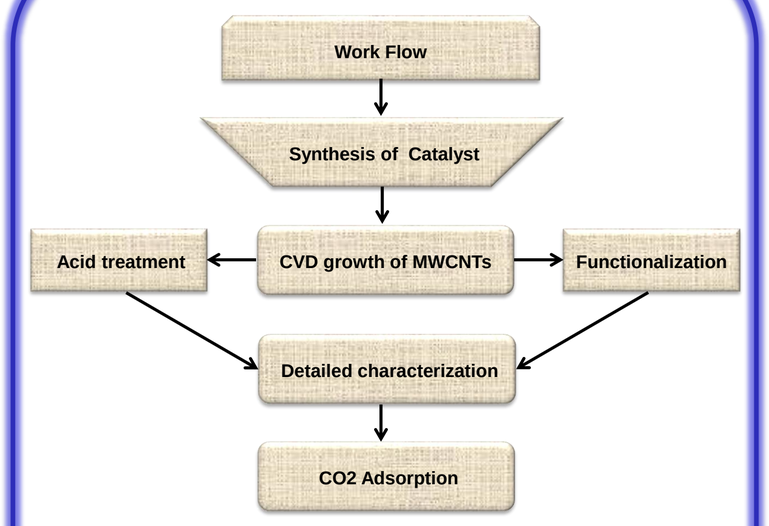
NOVELTY

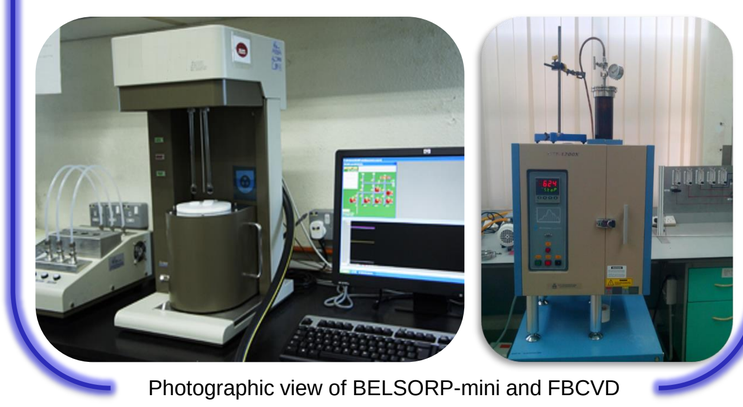


PHOTOGRAPHIC ILLUSTRATION



MATERIALS AND METHODS





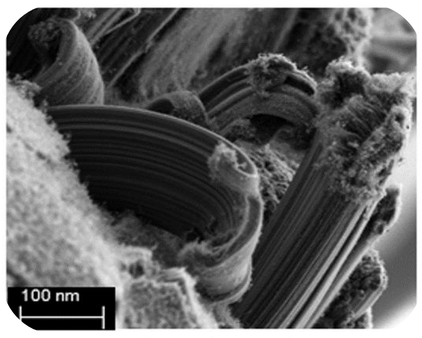
Photographic view of BELSORP-mini and FBCVD

CONCLUSIONS

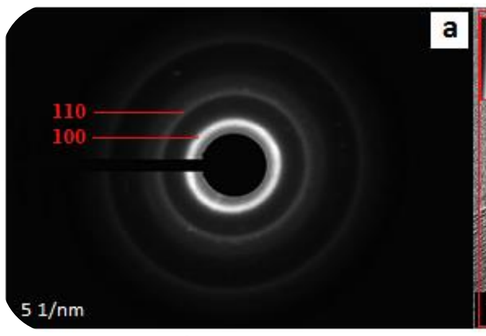
- **Highly crystalline MWCNT with better %yield were produced using a FBCVD reactor at optimum temperature of 800°C.**
- **CO_2 adsorbents were obtained after modifying MWCNTs, for their functionalization, with an acid mixture (HNO_3/H_2SO_4) and 3aminopropyl-triethoxysilane (APTS)**
- **FTIR analysis predicted maximum carboxyl, hydrophilic and amine group attachments to MWCNTs functionalized with APTS.**
- **SAP result revealed a decrease in surface area and pore volume of MWCNTs treated with HNO_3/H_2SO_4 followed by APTS functionalization.**
- **Highest degree of functionalization with I_D/I_G ratio of 0.84 was achieved in these investigations.**
- **CO_2 adsorption of 129 cm^3/g was found significantly higher than that reported by the previous researchers.**

RESULTS AND DISCUSSION

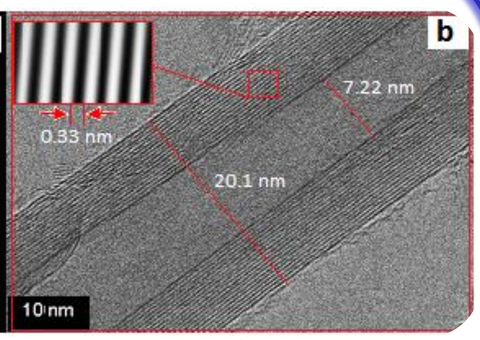
Grown MWCNTs



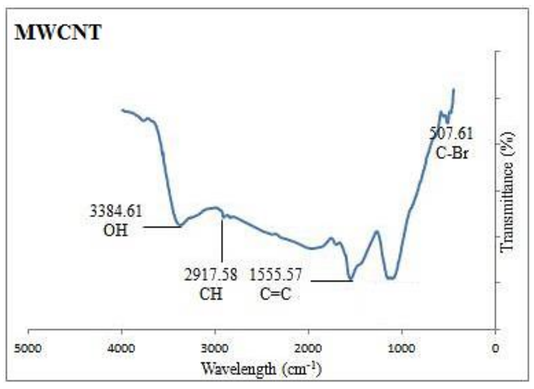
FESEM micrographs

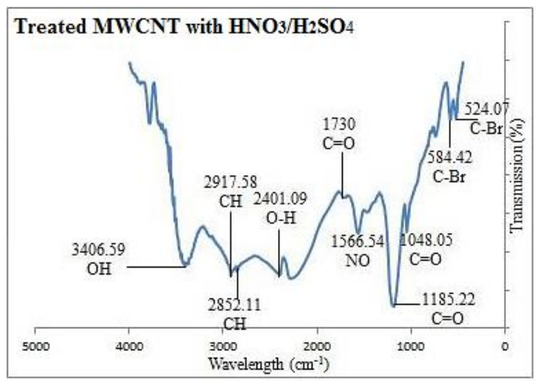


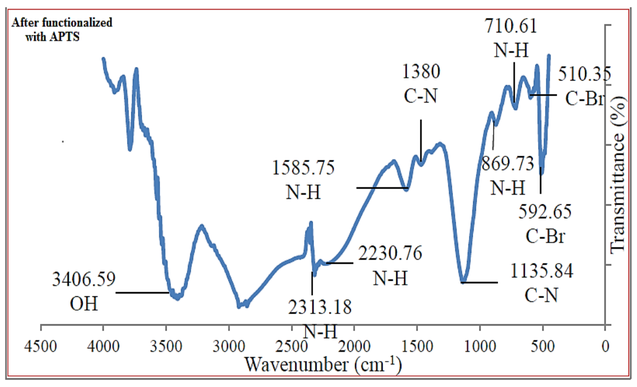
SAED pattern



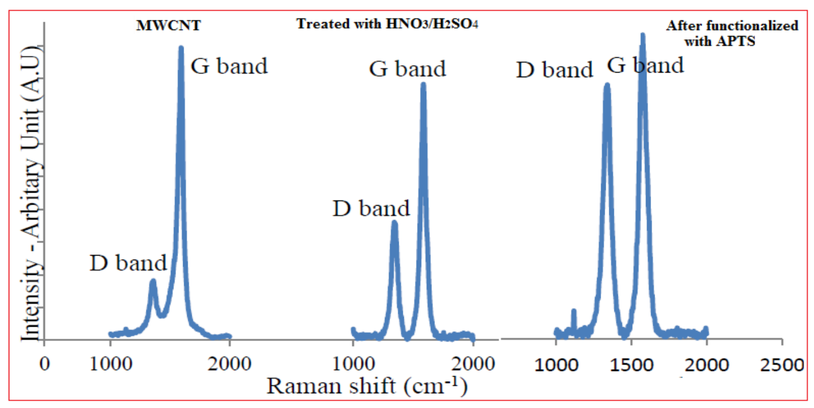
MWCNT tube structure







FTIR spectra of treated and untreated MWCNTs

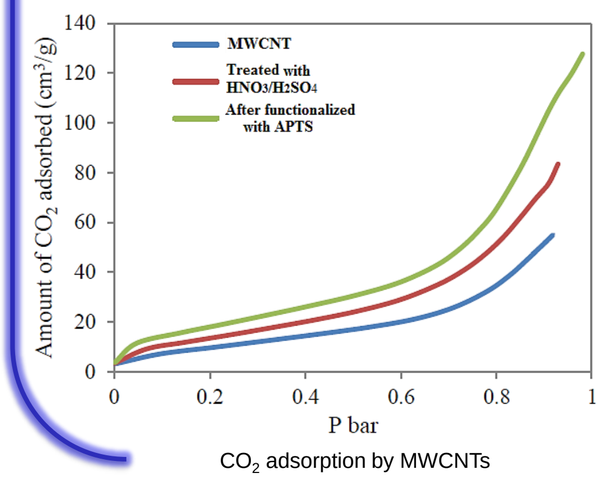


Raman spectra treated and untreated MWCNTs

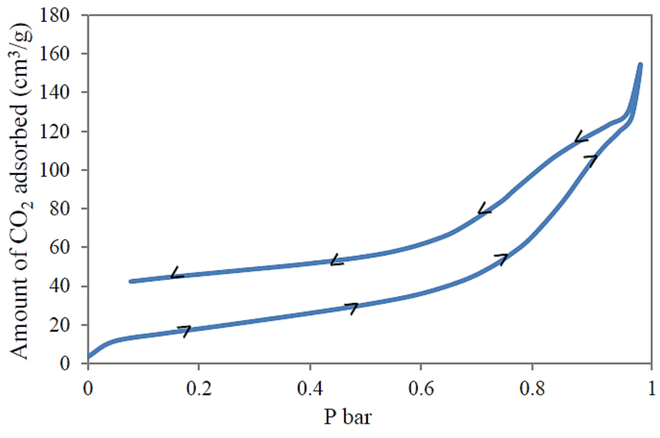
Sample	Surface Area (m^2/g)	Pore Volume (cm^3/g)	Intensity Ratio (I_D/I_G)
MWCNTs	447.1	0.69	0.20
HNO_3/H_2SO_4 treated MWCNTs	335.9	0.42	0.45
APTS functionalized MWCNTs	22.07	0.06	0.84

Literature Review	Adsorbents	Chemical	CO_2 Adsorption (cm^3/g)
Huang et al. (2002)	Silica xerogel	APTS	17.6
Chang et al. (2003)	SBA-15	APTS	25.0
Zelenak et al. (2008)	MWCNTs	APTS	27.0
Lu et al. (2008)	MWCNTs	APTS	66.0
Su et al. (2011)	MWCNTs	APTS	40.2
Gui et al. (2013)	MWCNTs	APTS	75.7
This study	MWCNTs	APTS	129.0

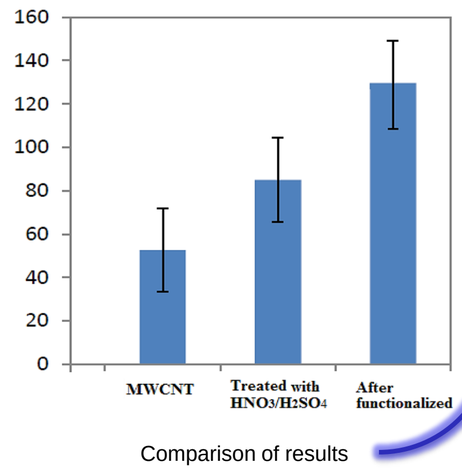
Comparison of current study with past literature



CO_2 adsorption by MWCNTs



CO_2 APTS treated MWCNTs



Comparison of results