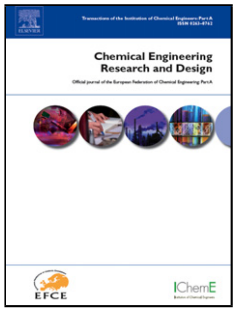

Title: Synthesis of carbon nanotube on stainless steel microfibrous composite—comparison of direct and indirect growth and its application in fixed bed m-cresol adsorption

Authors: Yi Yang, Huiping Zhang, Ying Yan

PII: S0263-8762(18)30473-8
DOI: https://doi.org/10.1016/j.cherd.2018.09.027
Reference: CHERD 3355

To appear in:

Received date: 26-7-2018
Revised date: 16-9-2018
Accepted date: 19-9-2018

Please cite this article as: Yang, Yi, Zhang, Huiping, Yan, Ying, Synthesis of carbon nanotube on stainless steel microfibrous composite—comparison of direct and indirect growth and its application in fixed bed m-cresol adsorption.Chemical Engineering Research and Design https://doi.org/10.1016/j.cherd.2018.09.027

Synthesis of carbon nanotube on stainless steel microfibrous composite—comparison of direct and indirect growth and its application in fixed bed m-cresol adsorption

Yi Yang, Huiping Zhang, Ying Yan*

School of Chemistry and Chemical Engineering, South China University of Technology, Guangzhou, Guangdong, 510640, China.

* Corresponding authors at: School of Chemistry and Chemical Engineering, South China University of Technology, Guangzhou, Guangdong, 510640, China.
E-mail address: yingyan@scut.edu.cn

Highlights

- CNTs are synthesized on microfibrous composites(SSMF) for the first time.
- The material can strengthen the interaction between CNT and SSMF.
- Direct and indirect growth methods are compared.
- The material can reduce the bed resistance and improve adsorption efficiency.

Abstract

Two types of novel carbon nanotube (CNT) integrated stainless steel microfibrous (SSMF) composites were prepared through a combined wet lay-up papermaking, sintering and thermal chemical vapor deposition (CVD) process. Preparation methods with (indirect growth) and without (direct growth) the pretreatment using Fe-Mo/Al_2O_3 catalysts were applied to grow CNTs on SSMF support(SSMF-CNT and SSMF-CCNT, respectively). The composites were characterized by scanning electron microscope(SEM), transmission electron microscope(TEM), N_2 adsorption-desorption, mercury porosimetry, X-ray photoelectron spectroscopy(XPS) and Raman spectra. Results show that CNTs are successfully synthesized onto the support by both methods. In SSMF-CNT, CNTs grow on the surface of stainless steel microfibers while in SSMF-CCNT, CNTs grow on the surface of microfibers as well as in the network structure. The textures of CNTs in two composites are also quite different. CNTs on SSMF-CNT show better degree of graphitization than CNTs on SSMF-CCNT. Finally, fixed bed adsorption experiments of m-cresol were carried out to compare the adsorption efficiency of fixed bed filled with individual CNT particles and structured fixed bed filled with both CNT particles and CNT-microfibrous composites. Results have shown that the structured fixed beds with CNT-microfibrous composite show a smaller m-cresol adsorption capacity but lower pressure drop and enhanced mass transfer efficiency compared with the individual CNT particle bed. Comparison between SSMF-CNT and SSMF-CCNT shows that SSMF-CNT shows a higher mass transfer efficiency and utilization efficiency than SSMF-CCNT due to different growth forms and texture properties, indicating that direct method is more suitable for the preparation of CNT-microfibrous composites for pollutant removal in waste water.

Keywords: carbon nanotubes; microfibrous composites; thermal CVD; growth method; adsorption

1 Introduction

Carbon nanotubes(CNTs) have attracted more and more attention since discovery for its unique microstructure and excellent physical and electrical properties. Nowadays, CNTs have found their way into many applications(Zhao et al. 2007). In recent years, CNTs have been synthesized on flexible substrates such as graphite foil(Li et al. 2001), aluminum foil(Su et al. 2011) and copper foil(Zhong et al. 2016). Scalable synthesis of CNTs on these metallic substrates is an attractive route to manufacturing of CNT-enhanced materials for applications including heat exchangers, filtration membranes, and electrochemical capacitors(Shearer et al. 2014; Volder et al. 2013). Researches in this area can be divided in two groups. The first one is indirect growth(Masarapu et al. 2007; Song et al. 2004; Yun et al. 2007), in which CNTs are synthesized on