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Article / Book Information

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（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Magnetic carbon nanotubes-TiO_2 (MCNT-TiO_2) has becoming a promising photocatalyst for the photocatalytic degradation of pharmaceuticals as stated in **chapter 1**. However, based on the literature review in **chapter 2**, the current preparation methods of MCNT-TiO_2 are not environmentally friendly and the practical application of MCNT-TiO_2 is limited. Therefore, the objective of this study is to propose a novel approach to prepare MCNT-TiO_2 and assess the performance of the developed material for the removal of pharmaceuticals in water containing natural organic matter (NOM). This study will have two different targets: first, to synthesis of new MCNT-TiO_2 and secondly to evaluate its performance in simple aqueous solutions using ultrapure water (UPW) first, and then gradually increase the complexity by using real water matrix to mimic the full scale application of MCNT-TiO_2.

Current methods to prepare MCNT-TiO_2 include extensive use of chemicals which is against the environmental friendly application of photocatalysis. Novel MCNT-TiO_2 that rely on the inherent magnetic properties of carbon nanotubes were synthesized and their photocatalytic activity was evaluated for the degradation of carbamazepine and sulfamethoxazole under solar irradiation (**chapter 3**). This approach consumes less chemicals than the conventional method, while it utilizes the external surface of the nanotube walls for TiO_2 particles. Moreover, the resulting MCNT-TiO_2 showed high photodegradation rate, high magnetic response, and regeneration relative to the TiO_2 reference catalyst. This MCNT-TiO_2 is showing its potential application for the removal of organic/chemical contaminants in aqueous environment.

The performance of MCNT-TiO_2 was further systematically evaluated in the presence of NOM (**Chapter 4**). NOM has been found to interact with photocatalysts and inhibit the photocatalytic degradation process. To date, the understanding of the NOM inhibition mechanisms (e.g., ROS scavenger, inner filter, and competitive adsorption) in photocatalysis degradation of organic micropollutants by CNT-TiO_2 is limited. Therefore, three standard NOM samples (e.g., Suwannee River Humic Acid [SRHA], Suwannee River Fulvic Acid [SRFA], and Suwannee River NOM

[SRNOM]) were characterized, and their inhibition behaviors in MCNT-TiO_2 photocatalysis of pharmaceutical (i.e., carbamazepine) was examined. Terrestrially derived NOM with high aromaticity and large molecular weight was the major fraction of organic matter that participate in the inhibition. The results from model analysis indicated that the relative importance of NOM inhibition mechanism in MCNT-TiO_2 photocatalysis followed the order of ROS scavenging > inner filter effect > competitive adsorption. Yet, the reduction in photodegradation rate of carbamazepine using MCNT-TiO_2 were less than those of bare TiO_2 due to the higher surface area of MCNT-TiO_2 provided enough active sites for the reaction of pharmaceuticals on MCNT-TiO_2. Therefore, MCNT-TiO_2 showed great potential application as an advanced treatment depending on the quality of NOM.

The potential application of MCNT-TiO_2 as an advanced treatment was further confirmed for the removal of carbamazepine in filtrated secondary treated domestic wastewater (SWW) and filtrated river water (RW) and compared with SRNOM (**Chapter 5**). The overall carbamazepine removal results from various water matrices followed the trend of SRNOM 1 mg.C/L (88.5 ± 1.6%) > RW 1 mg.C/L (86.9 ± 0.28%) > SRNOM 3 mg.C/L (79.82 ± 0.14%) > SWW 3 mg.C/L (41.4 ± 12.79%). The performance of MCNT-TiO_2 photocatalysis in real waters are relatively lower than in the presence of SRNOM. Therefore, besides the NOM quality and quantity, the presence of other water chemistries (e.g., inorganic species, pH, ionic strength, etc.) also affected the MCNT-TiO_2 photocatalysis performance and should be considered for the performance assessment and optimization.

Overall, the photocatalytic degradation of pharmaceuticals in water containing natural organic matter was investigated using MCNT-TiO_2 composite. The novel approach utilizing the inherent magnetic properties of CNT facilitate more environmentally friendly (i.e., consumes less chemicals) preparation method than the conventional method, and MCNT-TiO_2 exhibits the photodegradation activity for the removal of pharmaceuticals depending on the quantity and quality of the NOM in the water. In this way, this study will contribute to bringing the MCNT-TiO_2 to the applied field (e.g., by reducing the cost for water treatment application and enhance the understanding of the applicability of MCNT-TiO_2 in real water). This novel analytical approach to understand each inhibition mechanisms in CNT-TiO_2 photocatalysis can also contribute in environmental management by providing the information for the model prediction and system optimizations to overcome the potential losses of efficiency due to the NOM inhibition. To this end, following points are recommended for future studies (**chapter 6**):

- Understanding the effect of various inorganic species and other water chemistries (e.g., pH. ionic strength, etc) in MCNT-TiO_2 photocatalysis.
- Detailed studies on the transformation products formation and their toxicity.
- Reactor design followed by testing system with MCNT-TiO_2 on pilot scale.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
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