Secteur des Sciences et Technologies

Invitation à la soutenance publique de thèse de

Monsieur Franck William BOYOM TATCHEMO

Master en chimie

Pour l'obtention du grade de Docteur en sciences agronomiques et ingénierie biologique

«Synthesis of manganese dioxides (MnO_2) by gliding arc plasma route. Application to the catalytic degradation of Tartrazin Yellow in wastewaters»

qui se déroulera

le jeudi 20 décembre 2018 à 14h

Auditoire Doyen 21

Place des Doyens

1348 Louvain-la-Neuve

Membres du jury :

Prof. Eric Gaigneaux (UCLouvain), supervisor
Prof. Samuel Laminsi (Université de Yaoundé I, Cameroon), supervisor
Prof. Jacques Devaux (UCLouvain), chairperson
Prof. Christine Dupont (UCLouvain), secretary
Dr. Georges Kamgang Youbi (Université de Yaoundé I, Cameroon)
Prof. Tom Leyssens (UCLouvain)
Prof. Jean-François Lamonier (Université de Lille 1, France)
Prof. Miguel Angel Centeno (Instituto de Ciencia de Materiales de Sevilla (ICMS), Spain)

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In the recent years, a great interest in fundamental and applicative research was focused on the synthesis and the utilization of metal oxides nanoparticles. The synthesis of organized mesoporous materials with a transition-metal oxide framework has stimulated many researches over the past decade, in order to improve their industrial applications. Among them, MnO_2 is one of the most attractive inorganic materials not only because of its physical and chemical properties and wide range of applications, but also because of its low cost and environmentally benign nature.

The present thesis work aims at preparing mesoporous MnO_2 nanomaterials with high activity and stability, through a gliding arc plasma route, for catalytic, photocatalytic and plasmacatalytic oxidation of Tartrazin Yellow as organic pollutant. The first part consists in highlighting the redox properties of gliding arc plasma for the synthesis of MnO_2 nanomaterials for catalytic purposes. Polymorphs α-MnO_2 and γ-MnO_2 with specific surface areas of 98 and 48 m^2/g were plasma-synthesized at high voltage (600V) respectively via reduction of $KMnO_4$ and oxidation of $Mn(CH_3COO)_3.2H_2O$ by radicals $NO^{\cdot}$ and $HO^{\cdot}$ generated in gliding arc plasma medium. The same syntheses operated at low voltage (480V) give the polymorph δ-MnO_2 with specific surfaces of 186 and 289 m^2/g. Changes of polymorph and increase of the specific surface are thus recorded when the voltage decreases. These changes are also recorded when the airflow decreases. The catalytic tests of the different MnO_2 in the presence of H_2O_2, reveal the inefficiency of these catalysts for the elimination of Tartrazin Yellow (TY), due to the catalyzed decomposition of H_2O_2 in O_2 and H_2O molecules. At the opposite, the treatment with each catalyst alone (without input of H_2O_2) reveals a significant elimination of TY, which is due to the production of highly oxidizing species as $HO\cdot$ and $HO_2\cdot$ radicals, via the reaction between dissolved oxygen, water and electrons generated by each of the plasma-synthesized MnO_2. The effect is due to the presence of Mn in a mixed valence (III, IV). Photocatalytic tests reveal a significant contribution of solar radiation to the catalytic bleaching process of TY. A synergy between the plasma and each catalyst is recorded during the plasmacatalytic bleaching of TY. Moreover, the plasma temporal post-discharge species positively affect the catalytic properties of plasma-synthesized MnO_2. The second part studies the stability of plasma-synthesized MnO_2 nanomaterials. The results reveal that the modification of MnO_2 plasma-synthesized through ionic species (K^+, Na^+, Mg^{2+}) enhances its thermal and catalytic stability, compared to un-modified MnO_2 which changes polymorph after heating at high temperature (400°C) and loses its activity after the first catalytic cycle. Thus, gliding arc plasma appears as an innovative and ecological synthesis method of various polymorphs of MnO_2.