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Surface of carbon nanotubes for wet peroxide oxidation

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Catalytic wet peroxide oxidation (CWPO) is regarded as a potential solution for the treatment of aqueous effluents containing recalcitrant and toxic organic pollutants, difficult to remove by conventional biological processes, mainly if present at high concentrations (1-10 g L^{-1}) [1]. In a recent study, three magnetic carbon nanotube (CNT) samples, named E30 (undoped), A30 (completely N-doped) and E10A20 (partially N-doped), were synthesized by chemical vapor deposition and tested in the CWPO process, finding that N-doped hydrophilic surfaces promoted the fast decomposition of H_2O_2 into non-reactive species (H_2O and O_2), hindering CWPO [2].

For this study, the surfaces of the CNT samples were modified, analyzing the effect of these modifications on their activity during the CWPO of highly concentrated 4-nitrophenol solutions (4-NP, 5 g L^{-1}), using relatively mild operating conditions (atmospheric pressure, T = 50 °C, pH = 3), a catalyst load of 2.5 g L^{-1} and the stoichiometric amount of H_2O_2 needed for the complete mineralization of 4-NP. As shown in Table 1, the removal of surface functionalities by calcining the CNT samples at 800 °C enhances significantly their activity towards CWPO, evaluated in terms of 4-NP removal and total organic carbon (TOC) conversion, due to the increased hydrophobicity of the CNTs after the treatment. In particular, E30-calc and E10A20-calc were able to remove *ca.* 100 % of 4-NP after 8 h of operation, owning to high mineralization levels. On the contrary, the activity of the more hydrophobic surfaces became worse upon increasing the concentration of surface carboxylic acid groups by treating the CNT samples with nitric acid solutions (samples -NA).

Table 1. Catalytic activity during CWPO after 8 and 24 h

	8 h			24 h		
	$X_{4\text{-NP}}$ (%)	$X_{H_2O_2}$ (%)	X_{TOC} (%)	$X_{4\text{-NP}}$ (%)	$X_{H_2O_2}$ (%)	X_{TOC} (%)
E30	92	33	*n.d.*	100	54	59
E30-calc	99	40	45	100	59	59
E30-NA	38	89	18	99	70	54
E10A20	46	43	*n.d.*	88	67	44
E10A20-calc	97	71	38	99	99	48
E10A20-NA	38	31	4	60	42	13
A30	6	93	*n.d.*	9	93	18
A30-calc	31	90	22	35	99	22
A30-NA	22	99	0	48	100	0

n.d.: not determined.

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