

Nanocomposites and nanomaterials

Enzyme mimetic activity of carbon nanomaterials in diacyl peroxides decomposition

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Carbon nanomaterials (CNM) such as activated carbon (AC), carbon nanotubes (CNT) can affect to a variety of biologically important processes (hydrolysis of proteins, fats, esters, sucrose inversion, decomposition of peroxide, urea, etc.), i.e. carbon materials exhibit enzyme mimetic properties. The results of these studies can be used to create highly directional biocatalysts the replacement of enzymes in biotechnology. Decomposition of organic peroxides (OP) can be considered as a model to study the enzyme mimetic activity of carbon nanomaterials.

A number of carbon based materials such as natural (KAU) and synthetic (SKN) AC and CNT, their modified forms – oxidized: SKN_o, KAU_o, CNT_o; nitrogen containing (KAU+N, KAU_o+N, N-SKN, N-KAU, N-CNT, KAU_o-NH₂) and catalase (from bovine liver, Fluka) have been used as catalysts in reaction of OP decomposition. The investigated samples were characterized: specific surface area and average pore radius – by argon low-temperature adsorption-desorption method; sorption pore volume – by desiccator method, elements composition by Prehlya and Dumas methods. The chemical state of Nitrogen on the surface of samples has investigated by X-ray photoelectron spectroscopy; qualitative and quantitative characterization of functional groups on the surface - by Böehm titration. Michaelis constant (K_M , mM) and reversed to it Affinity constant (K_{af} , mM⁻¹) have been used to calculation of CNM and their modified forms catalytic activity from kinetic data.

The highest activity (higher then catalase) exhibit nitrogen containing CNM (N-KAU, N-CNT, N-SKN). Functionalization of carbon nanomaterials by Oxygen and Nitrogen changes electron donating ability of CNM surface, leading respectively to decrease or increase of their enzyme mimetic activity in the reaction of OP decomposition. It has been found that the catalytic activity of studied samples correlated with surface basicity and presence of quaternary nitrogen groups in structure. Therefore, nitrogen containing materials N-KAU and N-CNT can be used as efficient biocatalysts for the organic peroxides decomposition.