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ABSTRACTS

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CuO NPs Obtained by Laser Ablation for 4-Nitrophenol Hydrogenation and Dye Degradation

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Recently, Cu-based nanostructures have attracted particular attention due to their fundamental importance, photoconductive and photochemical properties. They have various potential applications in the field of heterogeneous catalysis and photocatalysis [1,2], including reduction of nitroaromatics in the presence of $NaBH_4$ as well as in dye degradation. A variety of methods have been developed to synthesize different morphologies and dimensions of Cu-based nanostructures [1], with pulsed laser ablation (PLA) in liquid being one of the most promising techniques. The CuO_x NPs with various phase composition (Cu, Cu_2O, Cu@Cu_2O, CuO), sizes, and morphology can be obtained by PLA [3].

In the present work, the features of formation of CuO_x NPs by PLA of copper in aqueous solutions of hydrogen peroxide and their catalytic properties towards reduction of nitroaromatics and dye degradation were studied.

The CuO_x NPs colloids were obtained by PLA of copper in aqueous solutions of hydrogen peroxide with different H_2O_2 concentrations (0.25, 0.1, 1%). The effect of H_2O_2 concentration on the composition, structure, and morphology of CuO_x NPs formed was studied by XRD, UV-vis spectroscopy, SEM, and TEM. The catalytic activity of CuO_x NP colloids was studied using the model reaction of 4-nitrophenol (4-NP) reduction to 4-aminophenol (4-AP) in the presence of $NaBH_4$ and oxidative degradation of methylene blue (MB) in the presence of H_2O_2. The photocatalytic activity of CuO NPs was additionally assessed towards the model dye degradation by visible light.

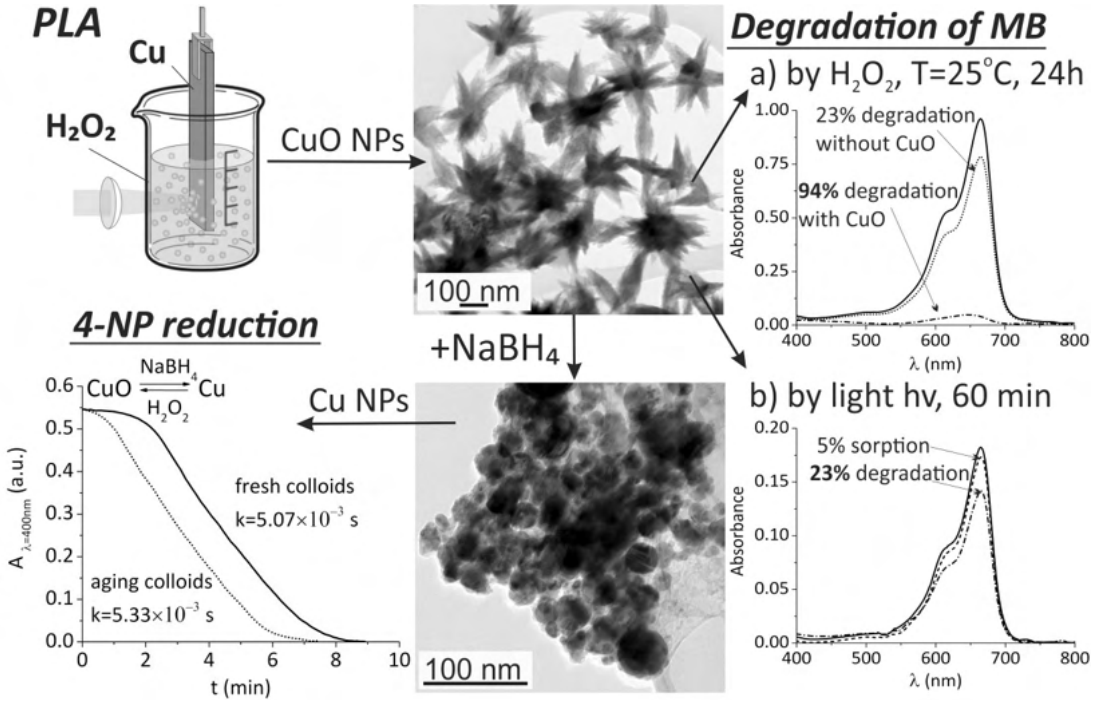

Fig. 1. A schematic representation of results

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The stable CuO_x NP colloids were obtained, with sheet- and flower-like CuO NPs being primarily formed in the presence of H_2O_2 (Fig. 1). The H_2O_2 concentration did not affect the structure and morphology of CuO NPs, but after the H_2O_2 consumption, the formation of cubic Cu_2O particle began.

It was found that the sheet- and flower-like CuO NPs obtained by PLA in H_2O_2 had a polycrystalline structure that contributed to their rapid reduction to 10–50 nm spherical Cu nanoparticles in the presence of $NaBH_4$ (Fig. 1). The obtained Cu NPs showed high catalytic activity towards 4-NP reduction to 4-AP in the presence of $NaBH_4$. The presence of H_2O_2 residues in the as-prepared CuO NP colloids was shown to prevent the reduction of CuO NPs, but did not affect the 4-NP reduction by $NaBH_4$ over the Cu NPs formed.

The oxidative degradation of the MB in the presence of H_2O_2 was shown to be very slow without the catalyst, while in the presence of the CuO NPs obtained by PLA in hydrogen peroxide solution the degradation was more efficient even at room temperature. Besides, the photocatalytic potential of the CuO NPs obtained by PLA under visible light was proved (Fig. 1).

References:

[1] M.B. Gawande, A. Goswami, F-X. Felpinet, T.Asefa, X. Huang, R. Silva, X. Zou, R. Zboril, R.S. Varma, Chem. Rev. 116 (2016) 3722.
[2] P. Deka, B.J. Borah, H. Saikia, P. Bharali, Chem. Rec. 2019, 19, 462–473.
[3] D.A. Goncharova, T.S. Kharlamova, I.N. Lapin, V.A. Svetlichnyi, Phys. Chem. C 123 (2019) 21731.