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The effect of surface area on photocatalytic degradation of methylene blue dye using libethenite - olivenite solid solution particles

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Wastewater generated from textile plants using different dyestuffs is a source of water pollution. Most of the present treatment methods have deficiencies: high-energy waste, high cost, and production of secondary pollutants. The promising alternatives are libethenite Cu_2PO_4OH and olivenite Cu_2AsO_4OH (LIB-OLI), which have excellent photocatalytic properties originating from the OH group that act as adsorption sites on the catalyst surface. An experimental investigation was undertaken to study the photocatalytic activity of the LIB-OLI solution series towards methylene blue (MB) photodegradation and to determine the effect of the specific surface area. The LIB-OLI solid solution series was synthesized using a hydrothermal method and characterized using XRD, SEM - EDS, FTIR, BET, and UV-vis spectroscopy. No surfactants or templates were added during preparation. By simply adjusting the pH from 2 to 8, the morphology of the end-members LIB-OLI varied from microrods (100 um in size) to walnut-shaped microspheres (2 um in size). Different pH values during the synthesis required different crystallization times. On this basis, it was possible to shorten the synthesis time to 24 h and maintain a relatively high specific surface area of the particles. The results revealed that upon increasing the pH value, the particle size decreased, leading to a larger surface area with less end-member particle agglomeration. It was determined that the synthesis process takes place the fastest (24 h) at pH=5. Under these conditions, seven members of the LIB-OLI solid solution series were synthesized. The specific surface area for the formation of the LIB-OLI solid solution series changed with P to As substitution: the lowest was 2.66 m^2/g for $Cu_2(P_{0.9}As_{0.1})O_4OH$, increased to 6.88 m^2/g for $Cu_2(P_{0.5}As_{0.5})O_4OH$ and the largest specific surface area equal to 10.72 m^2/g was for $Cu2(P_{0.3}As_{0.7})O_4OH$. The MB degradation efficiency of the Cu_2PO_4OH powder was ~60%, that of the intermediate member of the series was ~ 82%, and that of Cu2AsO4OH was ~ 84%, after 6h. This research was funded by NCN research grant no. 2021/41/N/ST10/03566