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Synthesis and characterization of MXene/metal-organic frameworks (MXOF) nanocomposite for dye removal application

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Organic dyes are the most important organic pollutants released from wastewater by different industries such as textile, printing, paper, and cosmetic industries [1]. Their non-biodegradable nature, toxicity, and potential adverse effects on human health have made them a big serious environmental concern [2]. Among various wastewater treatment approaches, adsorption-based processes, due to their simplicity, high efficiency, and reliability, have gained immense attention. Recently, a new class of two-dimensional transition metal carbides, nitrides, and carbonitrides, named MXenes were discovered by researchers at Drexel University. MXene NSs have a general formula of $M_{n+1}X_nT_x$(n=1–3) [1]. On the other hand, metal-organic frameworks (MOFs), as relatively new emerging nanoporous crystalline materials, possess a large specific surface area, tunable pore size, and high porosity. Zeolitic imidazolate frameworks (ZIFs) are a class of MOFs. ZIF-8 is a typical representative of ZIF materials, which is a kind of albite zeolite with a nanoporous structure [3]. In this study, a zinc-based metal-organic framework (MOF) decorated MXene (MXOF) nanocomposite was successfully synthesized [4] and utilized for the adsorptive removal of organic dyes from wastewater. Acid Red 88 (AR88) was selected as the model organic contaminant owing to its stable molecular structure and various application in the textile industry. Investigating the morphology of MXOF by field-emission scanning electron microscopy (FESEM) revealed the formation of crystalline spherical particles of ZIF-8 with an average particle size of ~450 nm over MXene NSs. Fourier transform infrared spectroscopy (FTIR) and X-ray diffraction (XRD) were also carried out to study, the structural and crystalline characteristics of MXOF. According to the results of the Brunner-Emmet-Teller (BET) analysis, the specific surface area and average pore size of the MXOF nanocomposite were found to be 1232.5 m^2/g and 0.5564 cm^3/g, respectively. Then, the dye absorption was studied showing a high adsorption capacity of 191.44 mg/g. The absorption isotherm and kinetics followed Temkepin isotherm model and pseudo-second-order kinetic model, respectively.

Keywords: Adsorption, Dye removal, Metal-organic frameworks; MXene nanosheets

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