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One Pot Synthesis of Cu–Ni–S/Ni Foam for the Simultaneous Removal and Detection of Norfloxacin

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Abstract : The residual antibiotics in the environment will pose a threat to the environment and human health. Thus, efficient removal and rapid detection of norfloxacin (NOR) in wastewater is very important. The main sources of NOR pollution are the agricultural, pharmaceutical industry and hospital wastewater. The total consumption of NOR in China can reach 5440 tons per year. It is found that neither animals nor humans can totally absorb and metabolize NOR, resulting in the excretion of NOR into the environment. Therefore, residual NOR has been detected in water bodies. The hazards of NOR in wastewater lie in three aspects: (1) the removal capacity of the wastewater treatment plant for NOR is limited (it is reported that the average removal efficiency of NOR in the wastewater treatment plant is only 68%); (2) NOR entering the environment will lead to the emergence of drug-resistant strains; (3) NOR is toxic to many aquatic species. At present, the removal and detection technologies of NOR are applied separately, which leads to a cumbersome operation process. The development of simultaneous adsorption-flocculation removal and FTIR detection of pollutants has three advantages: (1) Adsorption-flocculation technology promotes the detection technology (the enrichment effect on the material surface improves the detection ability); (2) The integration of adsorption-flocculation technology and detection technology reduces the material cost and makes the operation easier; (3) FTIR detection technology endows the water treatment agent with the ability of molecular recognition and semi-quantitative detection for pollutants. Thus, it is of great significance to develop a smart water treatment material with high removal capacity and detection ability for pollutants. This study explored the feasibility of combining NOR removal method with the semi-quantitative detection method. A magnetic Cu-Ni-S/Ni foam was synthesized by in-situ loading Cu-Ni-S nanostructures on the surface of Ni foam. The novelty of this material is the combination of adsorption-flocculation technology and semi-quantitative detection technology. Batch experiments showed that Cu-Ni-S/Ni foam has a high removal rate of NOR (96.92%), wide pH adaptability (pH=4.0-10.0) and strong ion interference resistance (0.1-100 mmol/L). According to the Langmuir fitting model, the removal capacity can reach 417.4 mg/g at 25 °C, which is much higher than that of other water treatment agents reported in most studies. Characterization analysis indicated that the main removal mechanisms are surface complexation, cation bridging, electrostatic attraction, precipitation and flocculation. Transmission FTIR detection experiments showed that NOR on Cu-Ni-S/Ni foam has easily recognizable FTIR fingerprints; the intensity of characteristic peaks roughly reflects the concentration information to some extent. This semi-quantitative detection method has a wide linear range (5-100 mg/L) and a low limit of detection (4.6 mg/L). These results show that Cu-Ni-S/Ni foam has excellent removal performance and semi-quantitative detection ability of NOR molecules. This paper provides a new idea for designing and preparing multi-functional water treatment materials to achieve simultaneous removal and semi-quantitative detection of organic pollutants in water.

Keywords : adsorption-flocculation, antibiotics detection, Cu-Ni-S/Ni foam, norfloxacin
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