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Simple fabrication and unprecedented visible light response of $NiNb_2O_6$/RGO heterojunctions for the degradation of emerging pollutants in water†

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Abstract

Utilization of environmentally friendly and effective synthesis methods to fabricate visible light responsive photocatalysts with impressive catalytic performance is desirable in photocatalytic water treatment. Herein, we employed the powerful and environmentally benign ultrasonic synthesis to hybridize hydrothermally prepared $NiNb_2O_6$ with varying amounts of RGO (5, 10 and 15 wt%) obtained *via* a modified Hummers' method. The samples were characterized extensively using analytical techniques such as XRD, SEM-EDX, TEM, UV-Vis DRS, PL, XPS, M-S and EIS, and subsequently employed for the degradation of doxycycline (DOX) and tetracycline hydrochloride (TC) in water under visible light exposure. The binary nanocomposites displayed enhanced activity compared to $NiNb_2O_6$, with the highest activity attained over the 10 wt% RGO sample ($NiNb_2O_6$/10 wt% RGO) which achieved 89.2% and 94.1% DOX and TC removal in 80 min, respectively. This was ascribed to improved visible light response, and charge separation and transfer. Furthermore, the influence of pH, pollutant initial concentration and photocatalyst dose was investigated. The hydroxyl radicals and holes were identified as the predominant reactive species responsible for degradation of both DOX and TC. Finally, a feasible charge transfer pathway was proposed to explain the formation of the reactive species and GC-MS analysis was employed to track the degradation route of DOX. This work presents a simple and effective route for coupling RGO and $NiNb_2O_6$ nanoparticles for antibiotic pollution abatement which is currently a major environmental concern.