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An efficient selective reduction of nitroarenes catalyzed by reusable silver-adsorbed waste nanocomposite

Giri S
Das R
Van der Westhuyzen CW
Maity A

ABSTRACT:

Silver nanocomposites (AgNCs) were produced by adsorption onto an electron-rich polypyrrole-mercaptoacetic acid (PPy-MAA) composite, known to be a highly efficient adsorbent for the removal of Ag^{+} ions from aqueous media in the remediation of metal- contaminated water sources. In situ reduction of Ag^{+} cations to Ag^{0} nanoparticles (NPs) was achieved in the absence of an additional reducing agent, and the AgNCs formed were characterized by FE-SEM, EDAX, HR-TEM, STEM, XRD, ATR-FTIR, and XPS. An investigation into the potential application of these AgNCs, effectively a waste product for further processing, as a catalyst for the reduction of variously substituted nitroarenes in water was undertaken in an effort to beneficiate the materials and determine the reaction's specificity. One composite having 11.14 ± 0.05 wt% Ag content was particularly active in these reductions, with aniline derivatives being prepared in 71–94% yields. The kinetics of the reaction was examined using 4- nitrophenol, a common water-soluble pollutant; pseudo-first-order kinetics was observed with predicted activation energy of 68.3 kJ/mol for this system. Furthermore, this AgNC displayed superior stability over 10 reaction cycles without loss of catalytic activity. A mechanism was elucidated based on these findings. The mild, economical, and efficient reduction method using a reusable “waste” material may prove a promising alternative for further industrial application.