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Silver-modified nanoscale zero-valent iron for efficient mercury removal from contaminated water

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Mercury contamination, often resulting from historical or ongoing (frequently illegal) mining activities, poses a serious environmental and public health threat due to its high toxicity and mobility. Although various strategies have been developed for mercury removal and immobilization, many are limited by insufficient efficiency or potential environmental side effects.

In this study, we present a nanotechnological approach based on nanoscale zero-valent iron particles modified with silver nanoparticles (nZVI–Ag), as previously described by Marková et al. (2013) [1]. Their performance was evaluated in comparison with commercially available iron nanoparticles.

Our results demonstrate that nZVI–Ag exhibits significantly enhanced mercury removal efficiency. The underlying mechanism involves the reduction of Hg(II) on the surface of metallic iron, followed by the formation of a stable silver–mercury amalgam. This process was confirmed using X-ray absorption spectroscopy, combining XANES and EXAFS analyses.

To assess practical applicability, the technology was tested on mercury-contaminated groundwater from the Mount Amiata mining district in Italy, historically the world's third-largest mercury-producing region.

Overall, the nZVI–Ag nanocomposite represents a highly effective solution for mercury remediation, substantially reducing the risk of toxic mercury vapor release and supporting safer environmental restoration efforts.

[1] Marková, Machalová Šišková, Filip, Čuda, Kolář, Šafářová, Medřík & Zbořil (2013), *Environmental Science & Technology* 47, 5285-5293.