



Nitrate reduction by bimetallic nanoparticles on soil mineral surface

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Since the start of industrial and agricultural revolutions, the water spheres are always under severe stress due to excessive usage and pollution by diverse chemical contaminants. Nitrate is one of such contaminants discharged from domestic, agricultural, and industrial sectors. Nitrate appearance in water spheres causes serious environmental issues, because it is toxic to human health, making water unpotable for human consumption, and 2) it can disturb food chains by the depletion of dissolved oxygen in water by nitrification. Therefore, Global and local environmental technology markets demand rapid, stable, and efficient denitrification treatment technologies. To date, nitrate reduction by catalysts has emerged as a feasible solution due to its high nitrate reduction capacity and its selective conversion to nitrogen. Significant research has been conducted to improve the reactivity and selectivity of bimetallic catalysts. Many interesting experimental results have been reported for the development of catalyst synthesis and optimization of relevant reaction conditions for better catalyst operation. However, there are many uncertainties for the selection of support materials of the catalysts. Most of support materials reported to date are refined and synthetic ones, while natural soil minerals have not been fully investigated, despite their huge potential reactivity, economical value, and abundance. In this study, we have reported the use of natural materials (sodium montmorillonite and modified red mud) as support materials of Sn-Pd-bimetallic catalysts for the reactive and selective reduction of nitrate. Synthesized Sn-Pd-montmorillonite showed 80% removal, while Sn-Pd-red mud showed 100% of (30 mg/L NO₃-N) nitrate removal. Sn-Pd-red mud has shown 10 times faster reaction kinetics than Sn-Pd-Na montmorillonite ($k = 0.75 \times 10^{-2} \text{ min}^{-1}$). The Sn-Pd-red mud catalyst also showed higher N₂ selectivity. The experimental results suggest that natural soil can be used for an efficient support material of the catalyst with a potential for the application to the sites contaminated with nitrate.