

Electrocatalytically Denitrifying Wastewater Based on Unique Nitrate-to-Nitrite Selectivity on Ag

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Abstract:

In our study, an exceptionally high selectivity of the electrocatalytic nitrate-to-nitrite transformation was discovered on Ag surfaces, among eighteen metals screened. It was demonstrated that this electrocatalytic step on oxide-derived Ag (OD-Ag), which possesses extended surface area (13 times) and enhanced specific activity (3 times) relative to Ag foil, can be coupled with a catalytic nitrite-to-dinitrogen step on a Pd catalyst using renewable hydrogen generated on-site by a water electrolyzer. We thereby proposed and demonstrated a combined electrocatalytic-catalytic process as an alternative strategy for innovative nitrate removal from agricultural wastewater with high selectivity of >95%. With future research and development, the combined process may hold the potential of tackling the ever-increasing nitrate pollution in water bodies to address its linked environmental and health issues. Strategically returning reactive nitrogen from wastewater back to the atmosphere in the inert form, this combined process is well-positioned to help close the global nitrogen cycle, one of the grand engineering challenges in the 21st century. In parallel with the applications in wastewater treatment, the Ag-based electrocatalytic nitrate-to-nitrate conversion with ultrahigh selectivity may be widely employed for designing cost-effective and energy-efficient syntheses of various nitrogen-based compounds in a distributed manufacturing fashion. The kinetics studies and computational insights could also be beneficial to advancing nitrogen-centric electrochemistry, materials science, and technologies.