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Carbon fiber paper supported nano-Pt electrode with high electrocatalytic activity for concentrated nitric acid reduction

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The electrochemical reduction of nitrate is a practical way to degrade nitrate, which is a harmful environmental contaminant present in some industrial wastewaters, while simultaneously generating many useful byproducts. Platinum electrocatalytic reduction of concentrated nitric acid currently utilizes Pt mesh or sheet but the catalyst configuration requires high Pt usage, thereby raising costs and the reductive efficiency needs to be greatly improved. In this work, we studied carbon fiber paper supported Pt nanoparticle (nano-Pt/CFP) electrodes for the electrocatalytic reduction of concentrated nitric acid. The nano-Pt/CFP (Pt-NP/CFP, Pt-NT/CFP) electrode exhibits remarkable electrocatalytic reactivity and high stability with greatly reduced Pt usage compared to the conventional Pt electrodes (Pt sheet or Pt mesh). The mechanism was investigated electrochemically and the gaseous products detected by online mass spectroscopy. The reduction on this electrode in concentrated nitric acid solution (≥4.0 M) involves a homogeneous autocatalysis process, with NO and N2O as the main products. A chemical equilibrium and a decomposition process occur in concentrated nitric acid. Thus, the electrocatalytic reduction process is significantly influenced by the composition of electrolyte. This work will provide new insights for preparing highly reactive electrodes, which we believe will arouse interest in utilizing this approach for industrial wastewater treatment, especially for the nuclear waste and low-level brine resulting from the regeneration of ion exchange resins.

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