Colorado Science and Engineering Fair

2025 Individual Project Abstract Form

Please print 2 copies of the completed form. Sign both copies, keep 1 for your notebook and submit 1 copy to your Regional Fair Director with your other paperwork.

Title of Project: Sustainable Nitrate Remediation and Ammonia Production via Electrocatalysis Using a One-Dimensional Ni-BTA Coordination Polymer

Finalist's Name: Sihan Liu

School and City: Colorado Rocky Mountain School, Carbondale

Sponsor's Name: Fujun Liu

Category: Environmental Engineering

Division: Senior (grades 9 - 12)

Abstract (250 words or less):

Nitrate contamination of groundwater through agricultural runoff, industrial effluent, and atmospheric deposition poses a serious threat to human health as well as the environment. In my hometown Tibetan Autonomous Region of Qinghai, this seemed to be a huge problem to causing distress to people. This work explores a new approach to overcoming this challenge by employing a one-dimensional coordination polymer, Ni-BTA, as an electrocatalyst for the electrocatalytic reduction of nitrate to ammonia. Unlike traditional processes of nitrate removal, such as reverse osmosis, biological denitrification, and ion exchange—characterized by excessive costs, secondary pollution, and inefficiency—this electrocatalytic reaction exploits renewable electricity, which means mild reaction conditions and no secondary waste.

The resultant Ni-BTA catalyst, based on SEM, TEM, and EDS analysis, consists of nanorod morphology with homogeneous dispersion of Ni, C, and N elements, which that attribute to high catalytic activity. Experimental results reveal that rates of nitrate conversion and ammonia formation are higher at higher voltage, temperature, and potassium nitrate concentration. Besides, the catalyst exhibits very good stability up to 25 cycles and acceptable activity over a wide pH range.

This study not only showcases the environmental significance of removing nitrate pollutants but also highlights the economic potential of producing ammonia, a valuable commodity, through sustainable electrocatalysis. These findings establish Ni-BTA as a promising material for nitrate remediation and resource recovery, offering a practical solution to Qinghai's environmental issue and a pressing global issue.

I hereby certify that the above statements are correct and the information provided in the Abstract is the result of one year's research. I also attest that the above properly reflects my own work.

Finalist's Signature: Date:

In addition, all students must complete the ISEF Student Checklist (1A), Research Plan, Approval Form (1B), and Checklist for Adult Sponsor (1), and any other ISEF forms required for this type of project. See the International Rules and Guidelines for form requirements. Return COPIES of all of these forms to your Regional Fair Director with you Finalist Verification/Permission Form. **A signed copy of this form must be included in your notebook.**