Western Washington University
Western CEDAR

College of the Environment Internship Reports | College of the Environment

2022

Characterizing Gold Nano-Particles with an ICP-MS Internship

Girnar Joshi

Follow this and additional works at: https://cedar.wwu.edu/cenv_internship

 Part of the Environmental Sciences Commons

Recommended Citation

Joshi, Girnar, "Characterizing Gold Nano-Particles with an ICP-MS Internship" (2022). *College of the Environment Internship Reports*. 18.
https://cedar.wwu.edu/cenv_internship/18

This Article is brought to you for free and open access by the College of the Environment at Western CEDAR. It has been accepted for inclusion in College of the Environment Internship Reports by an authorized administrator of Western CEDAR. For more information, please contact westerncedar@wwu.edu.

COLLEGE OF THE ENVIRONMENT

WESTERN WASHINGTON UNIVERSITY
MAKE WAVES.

Internship Title: Characterizing Gold Nano-Particles with an ICP-MS

Student Name: Philip Girnar Joshi

Internship Dates: 3/29/2022 - 6/10/2022

I grant to Western Washington University the non-exclusive royalty-free right to archive, reproduce, distribute, and display this Internship Report document in any and all forms, including electronic format, via any digital library mechanisms maintained by WWU.

I represent and warrant this is original work, and does not infringe or violate any rights of others. I warrant that I have obtained written permissions from the owner of any third party copyrighted material included in this document.

I acknowledge that I retain ownership rights to the copyright of this work, including but not limited to the right to use all or part of this work in future works, such as articles or books. Library users are granted permission for individual, research and non-commercial reproduction of this work for educational purposes only. Any further digital posting of this document requires specific permission from the author.

Any copying or publication of this document for commercial purposes, or for financial gain, is not allowed without my written permission.

STUDENT SIGNATURE 

DATE: 5/21/2022

Environmental Nanogeochemistry Lab
Supervisor Dr. Manuel Montaño
Girnar Joshi
WWU 2022

Characterizing Gold Nano-Particles with an ICP-MS

Introduction

In the spring of 2022, I worked with Dr. Montaño to prepare, collect and analyze data on gold nanoparticles (NP). We did this using a single particle method for an inductively coupled mass spectrometer(ICP-MS). Dr. Montaño and I met once a week to either go over data or discuss plans for the subsequent runs on the ICP-MS. I contributed to the project by preparing samples, running and monitoring the ICP-MS, and analyzing the data. The goal of this work was to do preliminary tests to see if spICP-MS can be used to monitor reactions with near-real-time feedback. The idea is that samples can be drawn as solutions and sent through the ICP-MS where a program would analyze the data and return to the chemical engineer the status of the reaction. This is important because as nanotechnology develops and the need to monitor environmental nano pollutants increases The work I did for Dr. Montaño's project is a small piece of what is needed to show this is a reliable application of ICP-MS.

spICP-MS

The instrument we used is the Agilent 7500ce Inductively Coupled Plasma Mass Spectrometer (ICP-MS). The ICP-MS is a machine that takes in a sample and returns a set of mass spectrum data. The samples we used were gold ion standards, gold nanoparticle (NP) standards, and gold nanorods(NR) made by Dr. Ying Bao in the WWU chemistry department.

Serial dilutions were made using micropipettes to produce our working samples. I made 4 gold standards diluted to 50 ppb, 10 ppb, 5 ppb, and 1 ppb, as well as gold NP 100 ppt dilutions, and diluted the gold NR by a factor of a million.

The diluted samples were introduced to the ICP-MS with an autosampler via a peristaltic pump. Once in the machine, a nebulizer turned the aqueous solution into a fine mist where it was then moved through some filters that remove especially large droplets. This was collected and disposed of as waste. The microdroplets that do make it through were then passed into a plasma (8000 degrees K). The argon plasma ionizes all compounds in the mist into an ion stream before pushing them through a skimmer cone. The skimmer cone has a tiny hole that only allows the hottest part of the plasma stream to pass through. This removes particles that were potentially unionized from the stream. Beyond the skimmer cone is a vacuum that pulls the plasma stream through before it meets the sampling cone. This removes more undesirable particles. Next, the ion stream is focused into a beam with a set of electromagnetic lenses. Then the beam is deflected such that any remaining unionized particles are dropped out of the beam. The next chamber is filled with helium gas that filters out any polyatomic ions out of the beam. The last step before the beam hits the detector is the quadropole. The beam moves through an electromagnetic field that is calibrated such that only a selected particle mass can make it through. This allows us to choose which ion in our sample we want data on.

Data Analysis

The data from the ICP-MS initially contains lots of background noise. First, the data must be graphed to determine a conservative estimate between signal and noise. This must be done for all samples. The data from the gold standard and the NP are then used to plot a calibration curve with a slope of mass per count. This is calibrated utilizing the fact that the diameter of the gold ions is a known constant. Now the counts of NR removed from the background values can be converted to a mass. Finally, since the NR are cylindrical, a length can be determined for each particle detected by the ICP-MS. We know the expected lengths from Dr. Ying Bao and a comparison of these can inform the methods of future studies.

Discussion

In working on this project I learned many things and gained some skills. I have determined that scheduling skills are crucial to science research. Any vagueness in a schedule between researchers seems to cause great inefficiency. Amongst reestablishing the importance of routinely checking my email and producing timely work, I learned that being able to communicate effectively and clearly with many people is difficult, especially when the subject is not something I know very well. Though it became easier as the quarter progressed, I found that asking frequent questions was the only way I could keep up. Keeping notes on conversations and meetings as well as creating a list of questions for the next meeting made it possible for me to continually engage with the work. As far as hard skills, I learned how to handle compressed gas safely, perform serial dilutions, operate the ICP-MS, and analyze data in excel. Though some skills took longer to develop than others, by the end I established a working grasp on all of them. One thing I found interesting was that the work we were doing was background work for an overarching idea. I went into the project thinking that research started with a question and then jumped right into the experiment. This experience showed me that for some things it's necessary to do lots of mini-experiments to narrow and focus the design of your initial question or methods before even starting on the main project. This emphasized the exploration side of science more than I knew was practiced. Not to say this project was an exploration but more so that it is a foundational study for a larger project yet to come.

My primary goal going into this project was to gain lab and research experience. I hoped for something in the physical sciences that was highly analytical and technical. In setting myself up for grad school and to better determine what I wanted to pursue as a career, I felt it was necessary to gain this type of experience. When I became aware of this project I realized it checked all the boxes and additionally was about a machine and field I knew very little about. This was very exciting and relates to my more broad goals. I want a career in which I continually learn new things. Additionally, I would like it to be in a field that has positive implications for the environment or/and human health. The application for ICP-MS is massive. From measuring nano pollutants in waterways to developing enzymes the scope of fields that utilize ICP-MS is huge. Not just the machine itself, but the scale and wide range of applications are very exciting to me. My academic goals have shifted towards chemistry and biochemistry having had this experience. In addition, having done work with Dr. Montaño I feel more prepared and excited for grad school.