Nabraj Bhattarai to SUNY College at Old Westbury

Nabraj Bhattarai, Ph.D.
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Dear chair of search committee
Department of Physics or Chemistry 9/28/18
SUNY College at Old Westbury
Long Island, NY

I am writing to formally submit my application for *Assistant Professor of Physics* position. I am very much excited to join as the team at SUNY College at Old Westbury. I believe that my passion for teaching and extensive research experiences in materials science will be the best fit for the department.

I have been working as a National Research Council (NRC) postdoctoral fellow at U.S. Naval Research Laboratory, Washington, D.C. since January 2017. I did my previous postdoctoral study at the Ames Laboratory in Ames, IA, from August 2014 to December 2016. I obtained my PhD in Physics from University of Texas at San Antonio (UTSA). My dissertation was focused on the synthesis and characterization of shape and size controlled metallic nanoparticles and atomically controlled nanoclusters. I utilized aberration-corrected scanning transmission electron microscope and advanced electron microscopy techniques for atomic resolution characterization. During my graduate studies, I was supported as a Teaching Assistant in Physics Department both at UTSA and Central Michigan University (CMU). I also have taught algebra and calculus-based engineering physics laboratories and electronics (UTSA, 2010-2011) and modern physics based laboratories (CMU, 2008-2009). This enabled me to gain valuable experience of teaching undergraduate labs in introductory Physics and Astronomy for about two years in the United States. In addition, I have four years of teaching experience of teaching college level physics courses from 2004 to 2008 in Thapathali Campus, Kathmandu, Nepal. I even served as **head of the department** of Science and Humanities from 2007 to 2008 of the same campus and managed a 20- member teams of teaching faculty and staff. I am comfortable teaching all levels of undergraduate courses for freshman and sophomore level including mechanics, electricity, heat, optics, modern physics and upper-level courses. My experience of teaching classes for science and non-science majors will be very helpful in teaching students with diverse majors.

In addition to providing lectures, I will bring materials sciences and electron microscopy expertise into the department and I intend to collaborate with professors within physics department and out of departments. In addition, I will use *in situ* electron microscopy holders such as liquid, heating, electrochemistry and biasing to study the phase transformations and other phenomena of different materials. I will actively engage students with hands-on preparation of colloidal nanoparticles and characterize those using available techniques/equipment on campus, including SEM and TEM. This one-two semester training will provide some fundamental research background to students and encourage them to take careers in companies, national laboratories or pursue graduate study. I plan to acquire competitive grants from university-wide or national agencies to start my independent research group to go along with my teaching responsibilities.

My academic background in physics, five years of teaching experiences, seven years of research experiences in nanoscience and electron microscopy, uniquely qualifies me for both teaching and research position. My experience working in collaboration with professors at different universities and scientists in various national laboratories qualifies me to collaborate across different disciplines within department, university and other institutions. If selected as a faculty member, I will teach a wide variety of introductory level to upper level physics courses and I will develop research projects that will directly inspire students and also contribute to the reputation of the department and university. Please find my application packet in the attached pdf files and please contact me if you need additional materials and information.

Thank you for your consideration. I look forward to hearing from you.

Electronically signed
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Permanent resident of United States (Authorized to work in USA)

Education

- **PhD,** Physics **Cumulative GPA 3.91** August 2014

  The University of Texas at San Antonio, San Antonio, TX

  Adviser: Prof. Miguel Jose-Yacaman

  Dissertation Title: Synthesis and electron microscopy characterization of bimetallic nanoparticles and atomically controlled nanoclusters

- **MS,** Physics August 2010

  Central Michigan University, Mount Pleasant, MI

  Adviser: Prof. Andrzej Sieradzan

  Dissertation Title: Photon transport through dense atomic vapors

- **MSc,** Physics May 2003
  Tribhuwan University, Kathmandu Nepal

Employment

- **NRC Research Fellow** 01/2017-Present

  U.S. Naval Research Laboratory, Washington, DC

- **Postdoctoral Researcher** 08/2014-12/2016

  Ames Laboratory, U.S. DOE, Ames, IA

- **Graduate Research/Teaching Assistant** 08/2010- 08/2014

  Department of Physics, University of Texas at San Antonio, San Antonio, TX

- **Graduate Research/Teaching Assistant** 08/2008- 08/2010

  Department of Physics, Central Michigan University, Mount Pleasant, MI

- **Head of Department (teaching and managing 20 teaching faculty)** 06/2007- 07/2008

  Department of Science and Humanities, Thapathali Campus, Kathmandu, Nepal

- **Lecturer** 08/2004- 07/2008

  Department of Science and Humanities, Thapathali Campus, Kathmandu, Nepal

Teaching Experiences

- Teaching Assistant, Department of Physics, UTSA 2010-2011
  - PHY 1611 (Algebra-based Physics I Lab)
  - PHY 1951 (Physics for Scientists and Engineers I Lab)
  - PHY 1971 (Physics for Scientists and Engineers II Lab)
- Teaching Assistant, Department of Physics, Central Michigan University 2008-2009
  - PHY 171 (Optics and Electronics lab)
- Physics Lecturer, Full-time, Department of Science and Humanities, Thapathali Campus, Nepal 2004-2008
  - Taught 11 and 12 grade physics and undergraduate engineering physics including mechanics, optics, heat, thermodynamics, electricity and magnetism *etc.*
  - Worked as department head for 1 year and managed ~20 teaching faculties

Research Expertise

Nanomaterial synthesis:

Shape- and size-controlled metallic, bimetallic and trimetallic nanoparticles including nanocubes, triangles, nanorods, core-shell/alloyed structures, magneto-plasmonic nanostructures, atomically controlled metallic (Au144, Au333) and bimetallic (CuAu144) nanoclusters, shape transformation of nanoparticles using DNA

Materials characterization (primary):

Scanning electron microscopy (SEM), transmission electron microscopy (TEM), scanning/transmission electron microscopy (S/TEM), chemical mapping (EDS and EELS), electron diffraction, weak beam dark field imaging, high resolution imaging, high angle annular dark field (HAADF) imaging, energy-filtered TEM (EFTEM), STEM tomography, *in situ* S/TEM study using liquid cell and electrochemistry holder, Focused Ion Beam (FIB) sample preparation

Materials characterization (secondary):

Optical spectroscopy, mass spectrometry including MALDI and ESI, powder XRD, FTIR, Raman spectroscopy, Zeta potential, magnetherm etc.

Technical Skills

- Seven years of experience using advanced electron microscopy techniques including aberration corrected electron microscopes
  - Experienced with UHV Nion UltraSTEM, JEOL ARM200F, JEOL 2200FS, JEOL 2010F, FEI Tecnai F20, FEI Titan for imaging and chemical mapping with EDX/EELS
  - Experienced using tomography 3D reconstruction
  - Highly proficient in using weak beam dark field imaging for strain mapping
  - Experienced using HAADF STEM and nanobeam electron diffraction for analyzing

defects at the interfaces, strain quantification and facet determination

- Trained more than 20 students and colleagues for using TEM during graduate study

- Four years of experience using in situ liquid cell TEM techniques in FEI Tecnai and JEOL 2200FS
  - Extensive experience with liquid cell assembly for in situ liquid cell experiments and dose rate controlled experiments
  - Experienced with liquid cell electrochemistry including in situ cyclic voltammetry
- Six years of experience in synthesizing shape and size controlled nanoparticles using wet chemical synthesis and their sample preparation for TEM
- Two years of experience using Zeta potential for nanoparticles charge determination

Research Experiences

Materials and Systems Branch, U.S. Naval Research Laboratory **Washington, DC**

NRC Research Associate, Advisers: Dr. Todd H. Brintlinger/Dr. Rhonda M. Stroud *01/2017-present*

In situ TEM investigation of electrochemistry of battery materials and nucleation and growth of semiconductor nanoparticles

- Identified the threshold electron dose rate for PbTe nanoparticles dissolution
- Revealed PbTe Nanorod formation using liquid cell TEM
- Demonstrated electrical potentials introduced by electron-beam during in situ Cyclic Voltammagrams in a commercial electrochemical liquid cell TEM
- Revealed $L1_0$ phase of PbTe nanoparticles and nanorods using aberration corrected STEM

Div of Materials Science & Engineering, The Ames Laboratory, U.S. DOE **Ames, IA**

Postdoctoral Research Associate, Adviser: Dr. Tanya Prozorov *08/2014-12/2016*

In situ STEM investigation of nucleation and growth mechanism in shape controlled nanoparticles

- Demonstrated the formation of Au-Pd core-shell nanoparticles using both closed cell and continuous flow liquid cell
- Revealed the role of DNA oligomers in shape transformation using liquid cell TEM
- Investigated the electron dose rates and flow rates in the growth of core-shell nanoparticles

University of Texas at San Antonio, Department of Physics **San Antonio, TX**

Graduate Research Assistant, Adviser: Prof. Miguel Jose-Yacaman *01/2011-07/2014*

Synthesis and electron microscopy characterization of bimetallic nanoparticles and atomically controlled nanoclusters

- Synthesized shape and size controlled nanoparticles/nanoclusters and investigated the growth mechanism (*ex situ)*
- Revealed the formation of stacking faults, partial dislocation in the interface of Au and Pd using atomically resolved HAADF-STEM images
- Revealed the epitaxial growth of core-shell particles using nanobeam diffraction
- Verified the elemental distribution using EDS, EELS

- Demonstrated the concave surface of Au-Pd core-shell nanocube using STEM 3D tomography reconstruction
- Revealed the core-shell particle is under strain using weak beam imaging and quantified the strain using geometric phase analysis (GPA) technique
- Demonstrated an alternate technique for crystal structure determination of molecular nanocrystals using high resolution HAADF STEM imaging and diffraction
- Trained more than 20 students and researchers in using electron microscopes (TEM, SEM) for material characterization
- Used Langmuir Blodgett trough for film preparation of nanoparticles and nanoclusters

Central Michigan University, Department of Physics **Mount Pleasant, MI**

Graduate Research Assistant: Prof. Andrzej Sieradzan *05/2009-07/2010*

Photon transport through dense atomic vapors

- Designed, assembled and conducted the experiment to investigate the photon transport phenomena through hot dense vapor

Awards and Recognition

- *National Research Council (NRC) Research Associate Fellowship 2017*, National Academy of Sciences, Washington, DC
- *Graduate Student Professional Development Award*, 2012 and 2013, Graduate School, UTSA
- *College of Sciences' Presidential Scholarship* 2011-2012 and 2013-2014 academic year, UTSA
- *College of Sciences' Dr. Harold G. Longbotham Endowed Scholarship,* 2013-2014 academic year, UTSA
- *Presidential Dissertation Fellowship*, 2013, Graduate School, UTSA
- *New Investigator Travel Award*, March 2013, American Physical Society Division of Chemical Physics (APS DCP)
- Student Poster Winner Physical Science, 2nd place, *M&M 2012*, Phoenix, AZ, 2012
- *CRTS-STEM Scholarship Award* for Spring and Summer, 2011, UTSA
- *RCMI Research Assistant Award* for Spring and Summer, 2011, UTSA
- *Merit based Scholarship Award* at undergraduate and graduate level at Tribhuwan University, 1998-2004, Kathmandu, Nepal

Proposal Funding

- *National Research Council (NRC)* Proposal, 2017, National Academy of Sciences, Washington, DC
- User proposal for using shared facility (TEM) in Brookhaven National Lab, Eric Stach (contact person), 2016
- User proposal for using shared facility (TEM) in Oak Ridge National Lab, Ray Unocic (contact person), 2015

Book/Chapter Publications

1. Nabraj Bhattarai, "Techniques for the characterization of ferromagnetic bimetallic nanoparticles" (***book chapter, Magnetic Characterization Techniques for Nanoparticles Springer Publication, 2017***).
2. Nabraj Bhattarai, "Photon transport through dense atomic vapors," ***(book, Lambert Academic Publishing, 2015).***
3. Nabraj Bhattarai, Subarna Khanal, J. J. Velazquez-Salazar and Miguel Jose-Yacaman, "Advanced electron microscopy in the study of multimetallic nanoparticles" (***book chapter, Advanced Transmission Electron Microscopy, Springer International Publishing, 2015***).

Journal Publications

1. Nabraj Bhattarai, Danielle L. Woodall, Janice E. Boercker, and Todd H. Brintlinger, "Controlling Dissolution of PbTe Nanoparticles in Organic Solvents during Liquid Cell Transmission Electron Microscopy" (Submitted).
2. G. Montella, A.P. Purdy, S. Qadri, N. Bhattarai, R. M. Stroud, and C.M. Roland, "Dispersion of Nanoclay in 1,4-Polybutadiene" (Just accepted).
3. David Black, Nabraj Bhattarai, S. B. H. Bach, and Robert L. Whetten, "Selection and Identification of Molecular Gold Clusters at the Nano(gram) Scale: Reversed Phase HPLC–ESI–MS of a Mixture of Au-Peth MPCs" ***The Journal of Physical Chemistry Letter***, *7* (***2016***), 3199-3205.
4. Nabraj Bhattarai and Tanya Prozorov, "Shape Transformation of Bimetallic Au-Pd Core-Shell Nanocubes to Multilayered Au-Pd-Au Core-Shell Hexagonal Platelets" ***Metallography, Microstructure, and Analysis, 4(2015)***, 481-487 **(**Invited article**).**
5. Nabraj Bhattarai, David Black, Snigdha Boppidi, Subarna Khanal, Daniel Bahena, Alfredo Tlahuice-Flores, S. B. H. Bach, Robert L. Whetten and Miguel Jose-Yacaman, "ESI-MS Identification of Abundant Copper-Gold Clusters Exhibiting High Plasmonic Character", ***Journal of Physical Chemistry C,*** *119* ***(2015),*** 10935–10942.
6. Borries Demeler, Tich-Lam Nguyen, Gary E. Gorbet, Virgil Schirf, Emre H. Brookes, Paul Mulvaney, Ala'a O. El-Ballouli, Jun Pan, Osman M. Bakr, Aysha K. Demeler, Blanca I. Hernandez Uribe, Nabraj Bhattarai, and Robert L. Whetten, "Characterization of Size, Anisotropy, and Density Heterogeneity of Nanoparticles by Sedimentation Velocity" ***Analytical Chemistry,*** *86* ***(2014),*** 7688-7695***.***
7. Subarna Khanal, Ana Spitale, Nabraj Bhattarai, Daniel Bahena, J Jesus Velazquez-Salazar, Sergio Mejía-Rosales, Marcelo M Mariscal, Miguel José-Yacaman, "Synthesis, characterization, and growth simulations of Cu–Pt bimetallic nanoclusters", ***Beilstein journal of nanotechnology , 5*** **(2014),** 1371-1379***.***
8. David M Black, Nabraj Bhattarai, Robert L Whetten, Stephan BH Bach, "Collision-Induced Dissociation of Monolayer Protected Clusters Au144 and Au130 in an Electrospray Time-of-Flight Mass Spectrometer", ***The Journal of Physical Chemistry A***, *118* (**2014**), 10679–

10687.

9. Subarna Khanal, Nabraj Bhattarai, David McMaster, Daniel Bahena, J. Jesus Velazquez-Salazar, and Miguel Jose-Yacaman, "Highly monodisperse multiply twinned AuCu/Pt trimetallic nanoparticles with high index surfaces", ***Physical Chemistry Chemical Physics,*** *16* (**2014**), 16278-16283.

10. Nabraj Bhattarai, Subarna Khanal, Daniel Bahena, Jimena A. Olmos-Asar, Robert L. Whetten, Marcelo M. Mariscal and Miguel Jose-Yacaman, "Structural order in ultrathin films of thiolate-protected gold nanocrystals: an experimental and theoretical study", ***Physical Chemistry Chemical Physics,*** *16* **(2014**), 18098-18104. (Cover page)

11. Subarna Khanal, Nabraj Bhattarai, J. J. Velazquez-Salazar, D. Bahena, A. Ponce, G. Soldano, M. M. Mariscal, S. J. Mejia-Rosales, and M. Jose-Yacaman, "Synthesis and Structural Characterization of AgPd/Pt Trimetallic Nanoparticles" ***Nanoscale,*** *5(***2013***),* 12456-12463.

12. Nabraj Bhattarai, Gilberto Casillas, Subarna Khanal, Daniel Bahena, Alfredo Tlahuice, Sergio Mejia, Arturo Ponce, Vinayak P. Dravid, Robert L. Whetten, Marcelo M. Mariscal, and Miguel Jose-Yacaman, Structure and composition of Au/Co Magnetoplasmonic Nanoparticles" ***MRS Communications,*** *available on CJO August 2013. doi:10.1557/mrc.2013.30*.

13. Subarna Khanal, Gilberto Casillas, Nabraj Bhattarai, J. Jesús Velázquez-Salazar, Arturo Ponce, Sergio Mejía-Rosales, and Miguel José-Yacamán, "CuS_2-passivated Au-core, Au_3Cu-shell nanoparticles analyzed by atomistic-resolution C_s-Corrected STEM" ***Langmuir***, *29* (**2013)**, 9231.

14. Nabraj Bhattarai, Gilberto Casillas, Subarna Khanal, J. Jesus Velasquez Salazar, Arturo Ponce and Miguel Jose-Yacaman, Origin and Shape evolution and of core-shell nanoparticles in Au-Pd: From few atoms to High Miller Index Facets. ***Journal of Nanoparticle Research****, 15* **(2013)**, 1660.

15. Daniel Bahena, Nabraj Bhattarai, Ulises Santiago, Alfredo Tlahuice, Arturo Ponce, Stephan B. H. Bach, Bokwon Yoon, Robert L. Whetten, Uzi Landman, and Miguel Jose-Yacaman, STEM Electron Diffraction and High Resolution Images Used in the Full Determination of the Crystal Structure of $Au_{144}(SR)_{60}$ Cluster. ***The Journal of Physical Chemistry Letter****, 4* (**2013**), 975-981.

16. Nabraj Bhattarai, Gilberto Casillas, Arturo Ponce and Miguel Jose-Yacaman, Strain relèase mechanism in bimetallic core-shell nanoparticles as revealed by Cs-corrected STEM. ***Surface Science****,* 609 (**2013**), 161-166.

17. Nabraj Bhattarai, Subarna Khanal, Pushpa Raj Pudasaini, Shanna Pahl, and Dulce Romero-Urbina, Citrate Stabilized Silver Nanoparticles: Study of Crystallography and Surface Properties. ***International Journal of Nanotechnology and Molecular Computation*** *3* (**2011**), 15-28.

Journal Publications (in preparation)

1. Todd Brintlinger and Nabraj Bhattarai, "Electrical Potentials Introduced by Electron-Beam during in situ Cyclic Voltammagrams in a Commercial Electrochemical Liquid Cell Transmission Electron Microscopy".

2. Nabraj Bhattarai, Danielle L. Woodall, Janice E. Boercker, and Todd H. Brintlinger, "Direct Observations of PbTe Nanorods Growth in Organic Solvents Using Liquid Cell Transmission Electron Microscopy".

3. Nabraj Bhattarai and Tanya Prozorov, "In situ STEM Investigation of Shape-Controlled Synthesis of Au-Pd Core-Shell Nanocubes."

Selected Publications (those appearing in Proceedings)

1. Nabraj Bhattarai, Danielle L. Woodall, Janice E. Boercker, and Todd H. Brintlinger, "Observation of PbTe Nanorod Formation using in situ Liquid Cell TEM". ***Microscopy and Microanalysis****,* 24 (S1), 2018, 296-297.
2. Nabraj Bhattarai and Tanya Prozorov, "In situ STEM Investigation of Shape-Controlled Synthesis of Au-Pd Core-Shell Nanocubes." ***Microscopy and Microanalysis****,* 21 (S3), 2015, 951-952.
3. Nabraj Bhattarai, S Khanal, JJ Velazquez-Salazar, D Bahena, A Ponce, and M Jose-Yacaman, "Study of thiol protected Au/Co nanoclusters using aberration corrected STEM", ***Microscopy and Microanalysis****,* 19 (S2), 2013, 1582-1583.
4. Nabraj Bhattarai, D Bahena, U Santiago, A Tlahuice, A Ponce, and M Jose-Yacaman "Study of Atomically Controlled Au Nanoclusters Using Aberration-Corrected STEM." ***Microscopy and Microanalysis****,* 19 (S2), 2013, 1446-1447.
5. Nabraj Bhattarai, G Casillas, A Ponce and M Jose-Yacaman, Study of core-shell Au-Pd nanocubes. ***Microscopy and Microanalysis****,* 18 (S2), **2012**, 1754-1755.

Selected Presentations

1. Nabraj Bhattarai, Danielle L. Woodall, Janice E. Boercker, and Todd H. Brintlinger, "Observation of PbTe Nanorod Formation using in situ Liquid Cell TEM". *M&M ,* 24 (S1), 2018, 296-297.
2. Nabraj Bhattarai, Danielle L. Woodall, Janice E. Boercker, and Todd H. Brintlinger, "Dissolution of PbTe Nanoparticles Observed with Liquid Cell Transmission Electron Microscopy". MRS Spring meeting 2018, April 2-6, Phoenix, AZ.
3. Todd Brintlinger and Nabraj Bhattarai, "Electrical Potentials Introduced by Electron-Beam during in situ Cyclic Voltammagrams in a Commercial Electrochemical Liquid Cell Transmission Electron Microscopy". APS March meeting 2018, March 5-9, Los Angeles, CA.
4. Nabraj Bhattarai and Tanya Prozorov, "In situ STEM Investigation of Shape transformation of AuPd core shell nanocubes into AuPdAu core shell nanostar like morphology." MRS Fall meeting 2015, Nov 29 - Dec 4, Boston, MA.
5. Nabraj Bhattarai and Tanya Prozorov, "In situ STEM Investigation of Shape-Controlled Synthesis of Au-Pd Core-Shell Nanocubes." M&M 2015, August 2-6, Portland, OR.
6. Nabraj Bhattarai, "Study of Au144 Nonoclusters Using STEM", November 13, 2013 Ready, Set, Research! Competition, Graduate School, UTSA, San Antonio, TX.
7. Nabraj Bhattarai, S. Khanal, D. Bahena, A. Ponce, and M. Jose-Yacaman; "Fabrication of Au144 nanoclusters and its investigation using Aberration Corrected scanning/transmission electron microscopy." 2013 SACNAS National Conference, October 3-6, 2013, San Antonio, TX.
8. Nabraj Bhattarai**,** Subarna Khanal, JJ Velazquez-Salazar, Daniel Bahena, Arturo Ponce, and Miguel Jose-Yacaman, "Study of thiol protected Au/Co nanoclusters using aberration corrected STEM", M&M 2013, August 4 - 8, 2013, Indianapolis, IN, USA.

9. Nabraj Bhattarai**,** Daniel Bahena, Ulises Santiago, Alfredo Tlahuice, Arturo Ponce, and Miguel Jose-Yacaman "Study of Atomically Controlled Au Nanoclusters Using Aberration-Corrected STEM." M&M 2013, August 4 - 8, 2013, Indianapolis, IN, USA.

10. Nabraj Bhattarai, Gilberto Casillas, J. Jesus Velasquez Salazar, Arturo Ponce and Miguel Jose-Yacaman, "Study of growth mechanism and atomic structure of Au-Pd core-shell nanocube by Cs-corrected scanning transmission electron microscopy." APS March meeting, March 18 – 22, 2013, Baltimore, Maryland, USA.

Professional Services and Synergistic Activities

1. Judge at *2014 ExxonMobil Texas Science and Engineering Fair* hosted by College of Sciences UTSA, March 22, 2014, San Antonio, TX
2. Organized and volunteered at *3rd Advanced Electron Microscopy Workshop,* 22-24 January, 2014, San Antonio, TX
3. Judge at *Thomas Edison High School Science Fair 2013* hosted by Center of Excellence in Infection Genomics (CEIG) and the UTSA College of Sciences January 11, 2014, UTSA, San Antonio, TX, USA
4. Judge at *Annual Science and Engineering Fair 2013* hosted by The John Jay Science & Engineering Academy, December 7, 2013, San Antonio, TX, USA

Professional Memberships

American Physical Society (APS), Materials Research Society (MRS)
Microscopy Society of America (MSA), Royal Society of Chemistry (RSC)
Life member of Nepal Physical Society (NPS)

Journal Reviewer

Nanotechnology, Materials Research Express, Materials Characterization, RSC Advances, Nanoscale, Physical Chemistry Chemical Physics, Metallography, Microstructure and Analysis

References

1. **Dr. Miguel Jose-Yacaman**
   Professor
   Physics Department
   University of Texas at San Antonio
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2. **Dr. Robert L Whetten**
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   Physics Department
   University of Texas at San Antonio
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   robert.whetten@utsa.edu, whettenz60@gmail.com

3. **Dr. Tanya Prozorov**
   Associate Scientist
   Division of Materials Sciences and Engineering
   US DOE, Ames Laboratory
   Office: 515-2943376
   Email: tprozoro@ameslab.gov

4. **Dr. Todd H. Brintlinger**
   Research Physicist

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Research Statement

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Overview

With properties of nanoparticles determined by their shape, size, and composition, synthesis of precisely-controlled nanocrystals determines their ultimate practical applications, and requires a thorough investigation of their structure at the atomic level. Such nanocrystals have already shown to be fundamental to modern science and could lead to disruptive technologies ranging from miniaturization of devices, high efficiency solar cells, more productive catalysts, to yet-to-discovered biomedical applications. My research interests encompass this entire spectrum from the synthesis of different nanoparticles and their atomic level characterization, including understanding their growth using both *ex situ* and *in situ* techniques, all the way up to the bulk characterization for applications. I will utilize wet chemical synthesis method for the synthesis of nanoparticles. For characterization, I mostly utilize advanced electron microscopy techniques, such as transmission electron microscope (TEM), scanning TEM (STEM), high resolution TEM (HRTEM), selected-area electron diffraction (SAED), electron energy loss spectroscopy (EELS), energy dispersive x-ray spectroscopy (EDS) *etc*. Such research necessarily requires undergraduate students, who will acquire hands-on expertise in this growing field which will give them the skills to place them in academic or industrial positions. Special emphasis will be given to engage and mentor women and underrepresented minorities. I anticipate this research to be funded primarily through grants from local and national sources including NSF, DOD (ONR, ARO, AFOSR) and DOE. In the succeeding paragraphs, I will elaborate on my specific research thrusts, previous experience, collaborations and student participation, and potential source of funding.

Research Thrusts

1. Shape and size controlled multimetallic nanoparticles

Multimetallic nanoparticles, made from more than two metals, present multifunctional properties and represent an emerging field of interest. I will synthesize these nanoparticles such as Au/Fe/Ag, Au/Fe/Pd, Au/Pt/Co *etc.* having both magnetic and plasmonic properties and anisotropic morphologies. The main focus will be on the synthesis of shape and size control of those multimetallic nanoparticles and investigate their properties at atomic resolution using advanced electron microscopy techniques[1]. By controlling the shape, we can control the exposed facets of nanocrystals, thereby tuning the number of atoms present in the surfaces, corners and edges, which modify their properties. In addition, I plan to actively collaborate within and out of physics

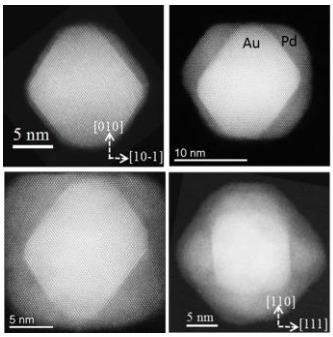

Figure 1. Z-Contrast STEM images of Au-Pd core-shell nanocubes. Nanocube is grown from fast growth along <111> directions than along <100> directions, lower contrast corresponds to Pd and higher contrast corresponds to Au[1].

department.

2. In situ S/TEM investigation to understand materials properties (*seeing is believing*)

In situ TEM experiments provide the direct observation of the nucleation, growth, assembly, phase changes, structural changes *etc*. Despite extensive research in the nanomaterials study, the early stages of growth mechanisms at its native state is still not clear. The *ex situ* study is "Quench and Look" and not able to provide information about such phenomena at their native state. *In situ* liquid cell experiments in near native reaction environments provide direct visualization of the nucleation and growth mechanism as it happens in liquid state (at its native state). This study will utilize using *in situ* liquid cell, heating, biasing, electrochemistry holders to investigate nucleation, growth, phase transformation, assembly process *etc.* I propose to study the formation and growth of anisotropic nanocrystals such as nanorods, nanostars using liquid cell TEM. Such study will provide direct evidence of the growth mechanisms and will be helpful to understand the growth process. In addition, I plan to collaborate with other professors in different projects related to *in situ* TEM. An example of formation of PbTe nanorod as seen using in situ liquid cell TEM is presented in figure 2. In this project, we used ~7 nm sized single crystal PbTe nanoparticles (see 1 sec frame) and studied the formation of nanorods. As shown in figure 2, after 20 secs, nearby particles selectively combine forming dimer like structure and longer nanorods are formed. This direct observation using *in situ* liquid cell TEM provides feedback for the growth mechanism such as oriented mechanisms vs oriented aggregations *etc*.

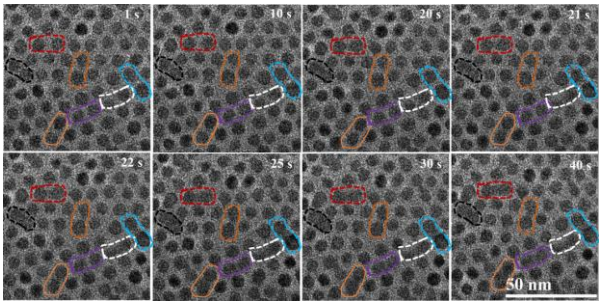

Figure 2. Selected region in the TEM image frames during in situ acquisition for the first minutes of the experiment forming nanorods. The time spanned is inserted on each frame.

3. Correlative Light and Electron Microscopy

This project will utilize the combination of light microscopy and electron microscopy[2]. Light or fluorescence microscopy will be used to image larger and living cells using fluorescence dyes. It can be used to study the protein aggregation or binding of nanoparticles with certain proteins. The same setup will be used in special liquid cell TEM/SEM without changing their native environment and utilize a low dose of electrons to image them minimizing the electron beam effects. This study will be able to see the whole structure using light microscope and zoom in to the specific area to get more detailed structure using liquid cell electron microscopy. Those techniques are complimentary to each other.

<u>Previous experience</u>

I have extensive (~7 years) experience in using electron microscopes, studying wide varieties of materials including shape and size controlled metallic, bimetallic and multimetallic nanoparticles. I have been actively publishing research articles on this field[1, 3-6]. In addition, I have utilized state–of-the-art aberration-corrected scanning transmission electron microscopes at atomic resolution and investigated the growth and strain release mechanisms. Recently, I have been using

in situ TEM techniques such as liquid cell and electrochemistry for studying nanoparticles growth and battery materials.

External Collaborations and Students Participations

My research project will be interdisciplinary and involves synthesis chemistry, different characterization techniques, image simulations and even the state of the art instrument such as aberration corrected scanning transmission electron microscope. Depending on the available resources and expertise, I plan to collaborate within and out of department, university and national laboratories including DOE user facilities. If the resources and expertise is not available within the college/university, I plan to work with my colleagues in different universities and national laboratories such as University of Texas at San Antonio (Prof. Yacaman, Prof. Whetten, Prof. Ponce), Iowa State University/Ames Lab (L. Zhou, T. Prozorov), U.S. Naval Research Laboratory (Todd Brintlinger) *etc.* In addition, I plan to use Department of Energy (DOE) user facilities including Oak Ridge National Lab (Ray Unocic), Brookhaven National lab (Dmitri Zakharov), Sandia National lab (Katherine L. Jungjohann) with competitive user proposals. This collaboration will provide students opportunities to utilize world class aberration-corrected S/TEMs and explore national lab facilities. Student involvement to such experiments and training will expose them to nanoscience, nanotechnology and electron microscopy. I am eager to sponsor my students to participate in outreach scientific activities at national or regional meetings and encourage them to apply for summer internships in DOE, DOD national labs, different R&D companies and other universities. This will prepare them to undertake the challenges for future faculty or materials science related jobs and also they will be motivated towards exciting field in nanoscience and nanotechnology.

Potential source of funding

This proposed research plan is flexible to change depending on available funding, joint equipment and other limitations. I intend to establish a vigorous externally-funded research program from different agencies: the National Science Foundation (NSF), the Department of Energy (DOE), the Office of Naval Research (ONR), the Army Research Office (ARO), and the Air Force Office of Scientific Research (AFOSR). Here are some calls on which I will focus:

- NSF, Division of Materials Research - Metals and Metallic Nanostructures (Program Officer: Gary J. Shiflet)
  https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505465&org=NSF&from_org=NSF
- NSF, Division of Materials Research – Designing Materials to Revolutionize and Engineer our Future (Program Officer: Dimitris Pavlidis)
  http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505073
- DOE, Early Career Research Program
  https://www.science.energy.gov/early-career/
- ARL, Material Science Program (Program Officer: Pani Varanasi, Patricia Huff)
  http://www.arl.army.mil/www/default.cfm?page=201
- ONR, Nanomaterials Program (Program Officer: Antti Makinen, Anthony C. Smith)
  http://www.onr.navy.mil/Contracts-Grants/Funding-Opportunities/Broad-Agency

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Teaching Statement and Philosophy-Nabraj Bhattarai, PhD

Teaching Statement and Philosophy

I have a great passion for teaching Physics and Materials Science. I often find that students have an impression of physics is a difficult subject. Indeed, it can be difficult if the theories are memorized without understanding. I strongly believe that physics is all about understanding of concepts rather than the memorization of definitions and equations. Students find learning exciting and meaningful only if they know the purpose and relevance of their learning. To encourage student learning, my teaching philosophy is based on three main principles: generating enthusiasm for physics, recognizing the uniqueness and the needs of each student, and, finally, creating a basis for lifelong learning. My teaching philosophy has developed through my experience as a high school science teacher and an undergraduate physics lecturer (four years) in Nepal, and as a teaching assistant (two semesters) at Central Michigan University (CMU) and University of Texas at San Antonio (UTSA). The courses I have taught from the introductory to higher level physics courses include mechanics, electricity and magnetism, heat and thermodynamics, optics, modern physics, sound and waves and others, along with associated laboratory courses at the undergraduate level.

Active participation by the student is important for a constructive learning. My goal as a teacher will be developing my students' problem solving strategies. I will encourage them to work collaboratively, reduce their science and math anxiety, and insure that they understand fundamental concepts. I believe the specific teaching method depends on the level of the course and the student. For the introductory level, one way of encouraging effective learning is to make learning fun, not a burden. I engage students in actively learning method as I believe that is two-way traffic. I will integrate experiments and demonstrations in my lecture. While teaching a lecture or recitation, I will engage students by starting with questions relevant to the topic. Moreover, I would like to motivate students to ask questions like "why", "what" and "how". This will help to understand the conceptual framework and help to solve numerical problems. Sometimes challenging/asking them to go through some of the reading before the lecture or sometimes assigning a group problem to generate questions will be useful. Instead of answering their questions directly, I provide students hints and ask questions to promote critical thinking. In my courses, I will use numerous case studies to explain the theory with real world data including recently published articles. I believe that all students can learn physics, although they may have different learning styles. In addition to communicating the materials in regular lectures, I will be available for open discussion with students. I will notify them about my office hours and also will be open to other time if students are unable to make it during office hours.

For upper level and advanced level courses, in addition to above mentioned methods, my pedagogical approach also takes a "learn by your-self" approach. For achieving this, I would like to provide the students with problems that they have to solve using the techniques learned in the lecture. In advanced level courses, to encourage the students better understand, I will assign a group activity in the form of a related research project. This not only helps the students understand that subject matter better, but will also foster independent scientific thinking and hone their ability in group interaction, both of which are needed for collaborative research.

As for my teaching interests, I am proficient teaching all classes and laboratories at undergraduate level. I have taught several classes of mechanics, electricity and magnetism, heat and thermodynamics, optics (geometric and wave), modern physics, sound and waves and others. My experience in teaching algebra- and calculus- based classes for students with non-science and science majors will be very helpful in diverse major classroom environment. In addition, I am interested in teaching upper level undergraduate classes including quantum mechanics and

classical electrodynamics. I am also interested in developing graduate level courses, such as advanced materials sciences and characterization, fundamentals of electron microscopy *etc*. During the semester, I will divide students into groups and assign them the project they are interested and related to the course. I will mentor them for the completion of projects including experimental details and characterization techniques. I will encourage them to present the results in order to help develop their oral presentation skills.

A good assessment plays vital role in succeeding teaching and learning process. I will utilize various assessment methods, such as, quizzes, regular homework and regular tests to measure students' progress. Students will receive prompt comments and feedback that will make timely improvement. In addition, I will utilize those activities as to evaluate my own success and will make adjustments in my teaching styles as needed. I will derive and solve example problems in class step by step.

I will always engage my students one-by-one in solving problems. Some students can easily tackle those problems, while others might need more help and even substantial help in some cases. As a teacher, my goal will be that my students have gained problem solving skills to help them achieve their professional goals. Overall, I focus on the mission of the department to promote a desire in my students to learn and succeed throughout their lives.

Diversity and Inclusion Statement-Nabraj Bhattarai, PhD

I was grown up in remote part of Nepal and have crossed so many obstacles to be in this position today. I feel proud of myself and want to utilize my learnings from obstacles and experiences in my class and want to help students with diverse backgrounds in order to achieve their goals. I was engineering physics teacher before moving to US for my graduate study and successfully utilized diversity and inclusion in my classroom.

Being Asian student, I have my own experiences during graduate study. Unfamiliarity of the culture, resources and not knowing proper way of handling the situations were main challenges at that time. Learning from those experiences, I will be in contact with the students and will address all those issues. A class is made from wide varieties of students, some of them are privileged, some are underrepresented and some are minorities. I will always keep focused to promote and facilitate women, minorities and underrepresented students. I will give them priority in hiring on my research projects. In the past, I have served as judges for different science competitions and promoted underrepresented students. In future, I plan to engage directly in promoting such students and promoting overall diversity of the University.

The University of Texas at San Antonio

has conferred upon

Nabraj Bhattarai

the degree of

Doctor of Philosophy

Physics

With all the rights and privileges thereunto appertaining.
In Witness Thereof, this diploma is granted by
Board of Regents upon recommendation of the Faculty.

Presented this sixteenth day of August, two thousand and fourteen.

George Perry
Dean

Ricardo Romo
President

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Francisco G. Cigarroa
Chancellor

Chairman, Board of Regents