

## **CV-Nabraj Bhattarai, PhD**

### **Dr. Nabraj Bhattarai**

National Research Council (NRC) Research Fellow

U.S. Naval Research Laboratory

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

#### **Education**

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- **PhD, Physics Cumulative GPA 3.91** August 2014  
The University of Texas at San Antonio, San Antonio, TX  
**Adviser: Prof. Miguel Jose-Yacamán**  
*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 Sieradzán**  
*Dissertation Title: Photon transport through dense atomic vapors*
- **MSc, Physics** May 2003  
Tribhuvan University, Kathmandu Nepal

#### **Employment**

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- **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

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- 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

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### 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 (Au<sub>144</sub>, Au<sub>333</sub>) and bimetallic (CuAu<sub>144</sub>) 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, magnetism etc.

## Technical Skills

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- 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**

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**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 Voltammograms in a commercial electrochemical liquid cell TEM
- Revealed L1<sub>0</sub> 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-Yacamán* *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**

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- *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, 2<sup>nd</sup> 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 Tribhuvan University, 1998-2004, Kathmandu, Nepal

### **Proposal Funding**

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- *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

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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

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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<sub>2</sub>-passivated Au-core, Au<sub>3</sub>Cu-shell nanoparticles analyzed by atomistic-resolution C<sub>s</sub>-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<sub>144</sub>(SR)<sub>60</sub> Cluster. *The Journal of Physical Chemistry Letter*, **4** (2013), 975-981.
16. Nabraj Bhattarai, Gilberto Casillas, Arturo Ponce and Miguel Jose-Yacaman, Strain release 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)

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1. Todd Brintlinger and Nabraj Bhattarai, “Electrical Potentials Introduced by Electron-Beam during in situ Cyclic Voltammograms 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)**

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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-Yacamán, “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-Yacamán “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-Yacamán, Study of core-shell Au-Pd nanocubes. *Microscopy and Microanalysis*, 18 (S2), 2012, 1754-1755.

### **Selected Presentations**

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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 Voltammograms 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 Au<sup>144</sup> Nanoclusters 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-Yacamán; “Fabrication of Au<sup>144</sup> 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**

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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 *3<sup>rd</sup> 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**

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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**

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

### **References**

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1. **Dr. Miguel Jose-Yacaman**  
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University of Texas at San Antonio  
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2. **Dr. Robert L Whetten**  
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3. **Dr. Tanya Prozorov**  
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- 4. Dr. Todd H. Brintlinger**  
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