Claudia Chaves Villarreal, Ph.D.
Materials Science Engineer

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Professional Profile

Scientist and engineer specialized in thin film electrochemical synthesis and characterization. Research for product concept, development and upgrading. Experienced in nanotechnology and microfabrication: thin films, nanoparticles, heterostructures, graphene, synthesis in liquid and vapor phase. Materials characterization: electron microscopy, thermal analysis, spectroscopy, XRD, electrochemical impedance, voltammetry and semiconductor electrical characterization. Developer of electronic devices such as sensors, batteries and photovoltaic cells. Experienced in proof-of-concept and implementation stages of projects related to biofuels, waste-to-energy and environmental education.

Education

- Ph.D. Materials Science and Engineering – University of California, Riverside – 2013 to 2018
- Master in Modern Manufacturing Systems (incomplete) Costa Rica Institute of Technology - 2011 to 2012
- Licenciatura Materials Science and Egineering – Instituto Tecnológico de Costa Rica- 2005 to 2010

Experience

- Professor and researcher at Instituto Tecnológico de Costa Rica – Materials Science and Engineering Department (June 2010- Now) and Nanotechnology Laboratory (June 2010-August 2013). Roles: Teaching courses of Materials Characterization and Materials Science, developing research project related to renewable energy generation and storage, and materials synthesis and characterization.
- Researcher at the Bionanotechnology Laboratory of Professor Ashok Mulchandani, UC Riverside (2013-Today). Reference: PhD. Ashok Mulchandani adani@engr.ucr.edu. Role: Development of biophotovolaic cell integrating carbon nanomaterials and proteins. Activities: growth and optimization of high quality graphene by CVD, fabrication and electrical characterization of electronic devices from graphene, hybridization of graphene with ZnO nanoparticles and nanowires by slip casting, CVD and electrodeposition, immobilization of photosynthetic protein bacteriorhodopsin on ZnO/Graphene hybrid, fabrication of sensitized solar cell devices, electrochemical characterization of photovoltaic devices and performance studies.
- Consultant in Project *Consolidation of the adoption of small and medium scale biogas technology in livestock farms in Costa Rica* by Wuppertal Institute for Climate, Environment and Energy and Asociación Costarricense de Biogás (April 2019-today). Reference: Adrián Sandí Campos info@asobiogas.org, +506 8398 3893. Roles: Project coordinator
- Expert at National Committee of Biogas Standard INTECO Inte/Ctn 41/Gt 01. Roles: Writing the standards *INTE E56: Requisitos mínimos para los sistemas de producción de biogás y sus componentes asociado*s and *INTE/ISO 20675:2019: Términos, definiciones y esquema de clasificación para la producción, acondicionamiento, mejoramiento y utilización de biogás*.
- Founder and director Biogas Para Todos (2010-Today). Reference: InterAmerican Development Bank Washington DC, Diana Herrera dsherrera@iabd.org, +1(202)-623-3175. Roles: Formulation, education, design, grant application, engineering, implementation, purchase, execution, follow-up.
- Science Laboratory Director Dr. Jaim Weizman Institute-Costa Rica. (January 2011- December 2012). Roles: Planning and preparation of classes based on national curriculum, laboratory manual

elaboration, safety manager, purchases, teaching. Reference: +(506) 2520-1013 cisdcr@centroisraelita.com

- Chemistry and Biology Professor at Mount View School (June – December 2010)
- Intern at the Costa Rican Petroleum Refinery (RECOPE) Research and development (February-July 2010) Role: Proposal and background research for polymer waste conversion into synthetic fuel.
- Materials Laboratory Assistant, TEC (February - December 2007) Materials characterization: X-ray diffraction, light and electron microscopy.

R&D Projects

- Development of biophotovoltaic device using bacteriorhodopsin protein
- Aluminum-ion batteries as renewable energy storing devices
- Electric Aircaft Research, Development and Testing in Costa Rica
- Development of oxides and alloys by severe plastic deformation for hydrogen production and storage
- Pilot program of domestic biogas systems network in Pococí, Limón
- Failure mechanisms characterization in TicoElectronics product

Publications

- Hui Wang, Pankaj Ramnani, Tung Pham, Claudia Chaves Villarreal, Xuejun Yu, Gang Liu, Ashok Mulchandani. *Gas Biosensor Arrays Based on Single-Stranded DNA-Functionalized Single-Walled Carbon Nanotubes for the Detection of Volatile Organic Compound Biomarkers Released by Huanglongbing Disease-Infected Citrus Trees.* Sensors 2019, 19(21), 4795; https://doi.org/10.3390/s19214795
- Trupti Terse-Thakoor, Pankaj Ramnani, Claudia Villarreal, Dong Yan, Thien-Toan Tran, Tung Pham, Ashok Mulchandani. *Graphene Nanogap Electrodes in Electrical Biosensing*. Biosensors and Bioelectronics. Volume 126, 1 February 2019, Pages 838-844. https://doi.org/10.1016/j.bios.2018.11.049
- Tung Pham, Pankaj Ramnani, Claudia C. Villarreal, Jhoann Lopez, Protik Das, Ikeun Lee, Mahesh R. Neupanee, Youngwoo Rheem, Ashok Mulchandani. MoS2-graphene heterostructures as efficient organic compounds sensing 2D materials. Carbon. Volume 142, February 2019, Pages 504-512
- Alejandro Martínez-Brenes, Claudia Chaves-Villarreal. *Inmovilización de la proteína fotoactiva bacteriorodopsina sobre óxido de zinc Aplicación en Celdas Solares Bio-Sensibilizadas*. Tecnología en Marcha Vol. 31, Núm. 4: Octubre-Noviembre 2018 pág. 49-62
- Claudia Chaves Villarreal, Danish Pirzada, Annie Wong, Derek Vi, Tung Pham and Ashok Mulchandani. *Characterisation of the Heterojunction Microstructure for Electrodeposited Vertical ZnO Nanorods on CVD-Graphene*. Materials Research Express 2018, 5:8. DOI: https://doi.org/10.1088/2053-1591/aace06
- Ali Benvidi, Nuvia M. Saucedo, Pankaj Ramnani, Claudia Villarreal, Ashok Mulchandani, Marzieh Dehghan Tezerjani, Shahriar Jahanbani. *Electro-Oxidized Monolayer CVD Graphene Film Transducer for Ultrasensitive Impedimetric DNA Biosensor*. Electroanalysis 2018, 30, 1– 11 DOI: 10.1002/elan.201700654
- Claudia C. Villarreal, Tung Pham, Pankaj Ramnani, Ashok Mulchandani. *Carbon allotropes as electrochemical sensors for environmental monitoring*. Current Opinion in Electrochemistry, 2017, 3 :106–113 DOI: 10.1016/j.coelec.2017.07.004

- Gerardo Madrigal-Monge, Claudia Chaves-Villareal. *CVD growth of ZnO nanorods in situ on graphene and the study of its application as photoanode for solar cells.* Tecnología en Marcha. Número Especial Movilidad Estudiantil 2017 4. Pág 104-118. DOI: 10.18845/tm.v30i5.3221
- Sushmee Badhulika, Trupti Terse, Claudia Chaves Villarreal, Ashok Mulchandani *Graphene hybrids: Synthesis strategies and applications in sensors and sensitized solar cells.* Frontiers in Chemistry 2015 3(38). DOI: 10.3389/fchem.2015.00038
- Alberto Hernández-Valle, Claudia Chaves Villarreal. *Síntesis de nanoestructuras de ZnO en vidrio recubierto con In2O3/SnO2 Deposición química en fase gaseosa*. Tecnología en Marcha, Edición especial Movilidad Estudiantil 2014, pag 41-51, 2014, DOI: 10.18845/tm.v27i0.2148
- Claudia Chaves Villarreal. *Evaluación de las técnicas SEM y EDS en la investigación nanotecnológica de catalizadores para la producción de biocombustibles*. Biblioteca José Figueres Ferrer Abril 2013
- Claudia Chaves Villarreal. *Conversión de residuos poliméricos a combustibles sintéticos en Costa Rica – Problemática nacional y estrategia de investigación y desarrollo* Biblioteca José Figueres Ferrer - Proyecto Final de Graduación, 2010
- Claudia Chaves Villarreal. *Aprovechamiento de monitores de TRC descartados en CR* Biblioteca José Figueres Ferrer – Práctica profesional, 2009

Conference presentations

- Claudia Villarreal. *How to succeed in biogas projects for rural areas in Costa Rica.* Agosto 2019, Congreso Interuniversitario de Extensión y Acción Social, San José
- Claudia Villarreal. *Biophotovoltaic system built from renewable carbon: integration of graphene hybrids and the phototrophic protein bacteriorhodopsin.* December 2018, 13o Simposio en Ciencia de Materiales y Nanotecnología, San Jose
- Engineers Without Borders at UCR, Claudia C. Villarreal *Implementation of multiphase integrated systems for organic waste treatment coupled with biogas production in family farms at the Northern Caribbean region of Costa Rica.* April 2018, Healing the Earth Decolonizing Education in Riverside, California
- Claudia C. Villarreal, Duyen Pham, David Rangel, Alejandro Martínez-Brenes, Senthil Prasad, Venkatesan Renugopalakrishnan, Ashok Mulchandani. *Immobilization of the photoactive protein bacteriorhodopsin on zinc oxide: Application in Bio-Sensitized Solar Cells.* April 2018, Energy Storage Technologies and Applications Conference hosted by the Winston Chung Global Energy Center (WCGEC) in Riverside, California
- Claudia C. Villarreal, Duyen Pham, David Rangel, Alejandro Martínez-Brenes, Senthil Prasad, Venkatesan Renugopalakrishnan, Ashok Mulchandani. *Immobilization of the photoactive protein bacteriorhodopsin on zinc oxide: Application in Bio-Sensitized Solar Cells.* Marzo 2018, MRS Spring Meeting in Phoenix, Arizona.
- Claudia C. Villarreal, David Rangel, Duyen Pham, Alejandro Martínez-Brenes, Senthil Prasad, Venkatesan Renugopalakrishnan, Ashok Mulchandani. *Integration of graphene hybrids and the photoactive protein bacteriorhodopsin for the advancement of carbon-based photovoltaics.* Marzo 2018. Conferencia: 255th ACS National Meeting & Exposition in New Orleans, Lousiana.
- Claudia Villarreal, Danish Pirzada, Annie Wong, Ashok K. Mulchandani. *Effect of Electrodeposition Variables on the Topography and Photoelectron Kinetics of Vertically-Aligned Zinc Oxide Nanorods Grown on Graphene.* Abril 2017. Conferencia: 253rd American Chemical Society National Meeting & Exposition in San Francisco, California.

- Claudia Villarreal, Derek Vi, Annie Wong, Ashok K. Mulchandani. *Electrodeposition of Single-Crystalline ZnO Nanorods on Graphene for Tin Oxide-Free Photoanodes.* Abril 2017. Conferencia: 2017 MRS® Spring Meeting – Phoenix, Arizona.
- Claudia Villarreal, Danish Pirzada, Annie Wong, Ashok K. Mulchandani. *Deposition of ZnO nanostructures on graphene: Application as tin oxide-free Photoanodes.* Abril 2017. Conferencia: 253rd American Chemical Society National Meeting & Exposition in San Francisco, California.
- Vanessa Chaves-Villarreal, Claudia Villarreal. *Implementation of multiphase-integrated systems for organic waste treatment coupled with biogas production in family farms at the northern Caribbean region of Costa Rica.* Marzo 2016. Conferencia: 251st American Chemical Society National Meeting & Exposition in San Diego, California.
- Claudia Villarreal, Trupti Terse, Pankaj Ramnani, Gerardo Madrigal, Ashok Mulchandani. *In situ-grown graphene 3D hybrids for the photoanode of dye-sensitized solar cells.* Marzo 2016. Conferencia: 251st American Chemical Society National Meeting & Exposition in San Diego, California
- Claudia Chaves Villarreal, Trupti Terse, Alberto Hernández-Valle, Ashok K Mulchandani *Graphene/semiconductor 3D hybrid nanomaterials for sensitized solar cells***.** March 2015 DOI: 10.13140/RG.2.1.2621.4886 Conference: 249th ACS National Meeting & Exposition Chemistry of Natural Resources, At Denver, Colorado.
- Claudia Chaves Villarreal, Trupti Terse, Alberto Hernández-Valle, Ashok K Mulchandani *Graphene/semiconductor 3D hybrid nanomaterials for sensitized solar cells***.** March 2015 DOI: 10.13140/RG.2.1.2621.4886 Conference: 249th ACS National Meeting & Exposition Chemistry of Natural Resources, At Denver, Colorado.
- Claudia Chaves Villarreal. *Caracterización de materiales por las técnicas SEM, TEM y AFM*. Facultad de Física, Universidad de San Carlos, Ciudad de Guatemala, Abril 2013.