Javier G. Fernandez (Ph.D, Associate Professor)

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Professional Profile

My research focuses on the broad **study, advancement, and application of biological materials in Development Science and Technology**. My work has been described as "*the materials that will change the future of manufacturing*" (Scientific American), "*the materials that could change the world*" (The Guardian), or "*The missing piece of circular economy*" (Engineering.com). In addition, I have been awarded the **world's most outstanding young researcher in materials science** by the Bayer Foundation, one of the ten **Asia Innovators Under 35** by MIT, and one of the **top innovators in sustainability** by the Launch Organization (NASA, US Agency for International Development, and US Department of State).

My vision is to improve the current design of materials and engineering solutions, incorporating biological designs and components at the molecular scale. My work and ideas have been extensively covered in the media. Additionally, my opinion on environmental policies and sustainable development can be found, for example, in personal interviews for BBC Radio, PBS, FOX News, NPR, and Financial Times, among others.

Professional Experience

- **2015-Present, Singapore University of Technology and Design (Singapore)**
  - 2022-Present, Chair of the Institutional Review Board
  - 2021-Present, Associate Professor (Tenured)
  - 2015-2021, Assistant Professor and Founding Academic Member
    Head of The Fermart Lab (Bioinspired and Integrative Science)

- **2019-Present, Chitonous Pte. Ltd. (Singapore)**
  - Founder
    → Interview

- **2010-2014, Harvard University/Wyss Institute (Boston, USA)**
  - 2011-2014, Research Associate in the Programmable Nanomaterials division
    Principal investigator in research and development of bio-inspired materials for sustainable and medical engineering.
  - 2010-2011, Research Associate in Bio-mimetic Microsystems
    Primary researcher in the study of protein/polysaccharide composites.

- **2009-2010, Massachusetts Institute of Technology (MIT)** *(Boston, USA)*
  - Post-doctoral fellow in tissue engineering
    Researcher in the development of a 3D self-assembly technology for the construction of artificial organs in-vitro.

Education

- **2004-2008 Ph.D. in NanoBioEngineering**

- Thesis: "*Fabrication and Characterization of Nanostructures on Chitosan Biocompatible Surfaces*"
University of Barcelona/Institute for Bioengineering of Catalonia (IBEC) (Best Ph.D. thesis of 2008 at the UB) (Spain)
Advisor: Chris Mills & Josep Samitier i Marti

- **2005-2008 MSc Social and Cultural Anthropology**

- Completed four years (of five) in the MSc of "Social and Cultural Anthropology" at the Spanish University of Distance Education. Halted when I finished the Ph.D. and began a postdoc in the USA.

• **2007 Research Visit**
- Development of a microfluidic reactor for the study of cellular response to environmental changes
University of Glasgow (UK)

• **2003-2004 MsC Nanotechnology**
- Thesis: "*Nanoengineered Magnetic Field Induced Superconductivity*"
Øresund University (Lund University, Technological University of Denmark and University of Copenhagen) (Sweden and Denmark)

• **1999-2004 MsC Fundamental Physics**
University of Cantabria (Spain)

Grants

(Only awarded competitive grants)

As Principal Investigator:

- **Singapore Kickstarter initiative (Industrial grant)-** *A biological PCB with the ability to form circuits at standard conditions using local percolation* (Singapore 2023-2025, $100,000)

- Ministry of Education (MOE) – *"Prediction and control of biomaterial deformations in large-scale manufacturing by deep structured learning"* (Singapore 2020-2023, $785,352)

- **National Research Foundation (NRF)** – *"From Genes to Products: Study and Application of Insect Structural Colors for Biomimetic Manufacture*" (Singapore 2020-2025, $5,749,856)

- **SUTD-MIT International Design Center (IDC)** – *"Additive manufacture with natural composites"* (Singapore 2016-2019, $250,000)

- **National Additive Manufacturing Innovation Cluster (NAMIC)** – "*Chitin-Cellulose bioinspired materials for AM*" (Singapore 2016-2019, $250,000)

As Co-Investigator:

- **Digital Manufacturing and Design and Centre (DManD)** – *"Hygroscopic Assembly*" (Singapore 2017, $150,000)

- **National Science Foundation (NRF),** *"Mesoscale self-assembly of hydrophilic materials"* (#0847287) (USA 2010-2014, $400,000)

Infrastructural Grants (For the establishment of SUTD)

- **SUTD-MIT International Design Center (IDC)** – *"Advanced Light Microscopy Core Facilities*" (Singapore 2018, $204,000, PI)

- **SUTD-MIT International Design Center (IDC)** – *"Microscopic FTIR*" (Singapore 2016, $331,500, PI)

- **SUTD-MIT International Design Center (IDC)** – *"Birefringence Measurement System*" (Singapore 2016, $116,000, PI)

- **SUTD-MIT International Design Center (IDC)** – *"Electron Backscatter Diffraction System*" (Singapore 2016, $156,200, Co-PI)

- **SUTD-MIT International Design Center (IDC)** – *"High Energy Electron Beam for 2D and 3D Patterning*" (Singapore 2015, $910,000, Co-PI)

- **SUTD-MIT International Design Center (IDC)** – *"Bio-analytical and Bio-medical infrastructures*" (Singapore 2015, $105,000, Co-PI)

Pre- and Post-Doctoral Fellowships

- **Generalitat de Catalunya**, Post-doctoral grant "Beatriu de Pinós" (Spain, 2009) *(Grant awarded, but declined to accept a better offer)*

- **Ministry of Science and Technology of Spain**, Grant for research collaboration within the University of Glasgow
The University of Glasgow - Department of Bioelectronics and Bioengineering (UK, 2007)

- **Ministry of Science and Technology of Spain**, "*Formation of University Professors* (FPU)" national research grant.
Institute for Bioengineering of Catalonia - Nanobioengineering laboratory (Spain, 2005-2008)

- **University of Barcelona/Generalitat de Catalunya**, Research fellowship for graduate students.
Universidad de Barcelona - Department of Electronic Engineering (Spain, 2004)

- **European Commission**, Socrates-Erasmus fellowship
Lund University (Sweden, 2003)

- **Ministry of Science and Technology of Spain**, Undergraduate student fellowship.
Universidad de Cantabria (Spain, 2002 and 2003)

Selected Awards

- 3D Pioneers (Materials and Sustainability), International award on design for sustainability (Germany, 2023)
Additive Manufacturing and Sustainability Award
→ Press release

- A' Design Award, Silver Design Award (Sustainability), International award on design for sustainability (Italy, 2019)
Design and Sustainability Award
→ Press release

- FormNext Innovation Award (Engineering), Purmundus Innovation Challenge (Germany, 2018)
Innovation Prize in product manufacturing.
→ Press release

- SG MARK (Design), Japan Good Design Mark & Design Singapore Council (Singapore, 2018 and 2019, awarded two consecutive years)
Design Innovation Award.
→ Press release

- LAUNCH (Innovation), NASA, US Agency for Intern. Develop. & US Dept. of State (Denmark, 2016)
Sustainability Innovation Award.
→ Press release

- MIT Technology Review (Innovation), Asia TR35 - Innovators Under 35 (US, 2015)
Award to the top ten outstanding innovators leading the next generation of technological breakthroughs.
→ Press release, Talk

- Bayer Foundation (Materials Science), Bayer Early Excellence in Science Award (US, 2014)
World's most significant young scientist in Materials Science and Engineering.
→ Press release

- Zwick GmbH & Co (Materials Science), Zwick Science Award (Germany, 2013)
International Award on Mechanical Testing
→ Press release

- University of Barcelona (Research), XIV Premi Claustre de Doctors (Spain, 2010)
Best Ph.D. thesis of 2008 at the UB
→ Press release *(In Catalan), talk (in Spanish)*

- **European Research Council (Research)**, European Ph.D. award (EU, 2008)
Award supported by the positive evaluation of Prof. Holger Schönherr (Universität Siegen, Germany) and reports of Prof. Lars Montelious (Lund University, Sweden) and Prof. Jon M. Cooper (University of Glasgow, UK)

Selected Awards Obtained by the Students

- **Singapore University of Technology and Design**, Yadunund Vijay (Master's Thesis, 2018)
- 2018 Best SUTD Master's Thesis.

- **Harvard University**, Suneil Seetharam (Master's Thesis, 2013)

- 2013 Harvard Class Marshal for Master of Liberal Arts (one of eight selected in a university-wide competition).
- 2013 Dean's Prize for Outstanding Master of Liberal Arts Thesis in Biotechnology.

Selected Publications

Leading intellectual author

(Selected indexed and original contributions only, without conference papers, reviews, or books)

A biological approach to metalworking based on chitinous colloids and composites
Ng Shiwei, Ng Benjamin, Robert E. Simpson, Javier G. Fernandez*. *Advanced Materials*, 2024 (*In Publication*) (Arxiv)

On Mars as it is on Earth: Bioinspired Technologies for Sustainability on Earth are Paving the Way for a New Era of Space Exploration *(Perspective)*
Javier G. Fernandez*, Ng Shiwei. *APL Materials*, 2024. **12**(2) 0191443
→ Selected by the editorial team, this article is featured as "one of the journal's best."

Large-scale biomimetic reproduction of arthropod cuticle iridescence and its use in conformal biodegradable coatings
Akshayakumar Kompa, Cédric Finet, Vinodkumar Saranathan, Javier G. Fernandez*. *Advanced Engineering Materials*, 2024, 2301713

Shrinkage prediction and correction in material extrusion of cellulose-chitin biopolymers using neural network regression
Hoo Jian Li, Stylianos Dritsas, Javier G. Fernandez*. *Virtual and Physical Prototyping*, 2023, **18**(1), e2225039

Secondary reorientation and hygroscopic forces in chitinous biopolymers and their use for passive and biochemical actuation
B Rukmanikrishnan, Kenneth Tracy, Javier G. Fernandez*. *Advanced Materials Technologies,* 2023, 2300639
→ Reproduction of the arthropod molting to harvest energy and movement from weather and environmental changes. Highlighted because of its role in the production of intelligent green materials (Weather.com)

From qualitative data to correlation using deep generative networks: Demonstrating the relation of nuclear position with the arrangement of actin filaments
Jyothsna Vasudevan†, Chuanxia Zheng†, James G. Wan, Lim Chwee Teck, Javier G. Fernandez*. *PLoS One*, 2022. **17**(7), e0271056.
→ Study on overcoming the limitations of the traditional scientific method using machine learning to parametrize complex biological systems. Covered by several specialized media outlets (e.g., Medical News)

The height of chitinous ridges alone produces the entire structural color palette
Hemant Kumar Raut†, Qifeng Ruan†, Cédric Finet, Vinodkumar Saranathan, Joel K.W. Yang, Javier G. Fernandez*. *Advanced Materials Interfaces*, 2022. 2201419.

Hand-eye calibration for 2D laser profile scanners using straight edges of common objects
Jing Xu, Hoo Jian Li, Stylianos Dritsas, Javier G. Fernandez*. *Robotics and Computer-Integrated Manufacturing*, 2022. **73**C, 102221.

Geometrical Control of Degradation and Cell Delivery in 3D Printed Nanocellulose Hydrogels
Rupambika Das, Cheng Pau Lee, Anupama Sarojini Prakash, Michinao Hashimoto, Javier G. Fernandez*. *Materials Today*, 2022. **30**, 103023.

Measurements of the swimming speeds of motile microorganisms using object tracking and their correlation with water pollution and rheology levels
Ashaa Shunmugam, Gowtham Subramanian, Javier G. Fernandez*. *Scientific Reports*, 2021. **11**, 11821.
→ Demonstration of water quality assessment based on computer vision and microorganisms' behavior. These results were highlighted by specialized media (Environment Magazine, Gizmag) and spun out a company (currently being incorporated).

Environmental Attributes of Fungal-Like Adhesive Materials and Future Directions for Bioinspired Manufacturing
Ng Shiwei, Song Bin, Javier G. Fernandez*. *Journal of Cleaner Production,* 2021. **282**, 125335.

Cell migration and breast cancer metastasis in biomimetic extracellular matrices with independently tunable stiffness
Jyothsna Vasudevan, Lim Chwee Teck, Javier G. Fernandez*. *Advanced Functional Materials*, 2020. 2005383

Martian biolith: A bioinspired regolith composite for closed-loop extraterrestrial manufacturing
Ng Shiwei, Stylianos Dritsas, Javier G. Fernandez*. *PLoS One*, 2020. **15**(9), e0238606
→ Unique material conceived within a minimum ecosystem supporting the first humans on Mars and covered by CNN, the Daily Mail, The Wire, ARSTechnica, among others, because of the correlation between sustainable manufacturing and space exploration.

Cellulose nanofibers for encapsulation and pluripotency preservation in the early development of embryonic stem cells
Rupambika Das, Javier G. Fernandez*. Biomacromolecules, 2020. **21**(12), 4814-4822

Additive manufacturing enables the production of de novo cardiomyocytes by controlling embryoid body aggregation
RupambikaDas, Javier G. Fernandez*, *Bioprinting*, 2020. **20**, e00091

Tough and Strong: Cross-Lamella Design Provides Multifunctionality to Biomimetic Nacre
Hemant Kumar Raut, Alan F. Schwartzman, Rupambika Das, Caroline A. Ross, Javier G. Fernandez*. *ACS Nano*, 2020. **14**(8), 9771–9779

Characterization and manipulation of *Paramecium aurelia* using a micro-electromigration chip and computer vision
Ashaa Shunmugam, Javier G. Fernandez*. *Advanced Materials Technologies*, 2020. **6**, 2000152

The Biomaterial Age: The Transition Toward a More Sustainable Society Will Be Determined by Advances in Controlling Biological Processes *(Perspective)*
Javier G. Fernandez*, Stylianos Dritsas. *Matter*, 2020. **2**(6), 1352-1355

Circular manufacturing of chitinous bio-composites via bioconversion of urban refuse
Naresh D. Sanandiya, Christoph Ottenheim, Junwei Phua, Stylianos Dritsas, Javier G. Fernandez*. *Scientific Reports*, 2020. **10**, 4632
→ The first demonstration of a generalizable technological path to circular manufacture. Praised also for the ability to produce self-sustainable manufacturing regions, independent of the globalized supply chain.

Stimuli-responsive injectable cellulose thixogel for cell encapsulation
Naresh D. Sanandiya, Jyothsna Vasudevan, Rupambika Das, Chwee Teck Lim, and Javier G. Fernandez*. *International Journal of Biological Macromolecules*, 2019. **130**, 1009-1017

Control of Process Settings for Large-Scale Additive Manufacturing with Sustainable Natural Composites. Yadunund Vijay, Naresh D. Sanandiya, Stylianos Dritsas, Javier G. Fernandez*. *Journal of Mechanical Design*, 2019. 1-15

Digital Fabrication with Natural Composites
Stylianos Dritsas, Samuel Halim, Yadunund Vijay, Naresh Sanandiya, Javier G. Fernandez*. *Construction Robotics*, 2018. **2,** 41-51

Large-scale additive manufacturing with bioinspired cellulosic materials
Naresh D. Sanandiya, Yadunund Vijay, Marina Dimopoulou, Stylianos Dritsas, and Javier G. Fernandez*. *Scientific Reports*, 2018. **8**(1), 8642
→ Largest fully biological structure ever produced by additive manufacturing. Highlighted for its impact on the development of sustainable manufacturing and circular economy. Most read open-access article in material sciences in 2018.

Direct bonding of biomaterials to tissues using transglutaminase for surgical repair or device implantation
Javier G. Fernandez, Suneil Seetharam, Christopher Ding, Juani Feliz, Ed Doherty, and Donald E. Ingber*. *Tissue Engineering Part A*, 2016. **23**(4), 135-142

Chitin is endogenously produced in vertebrates
W. Joyce Tang†, Javier G. Fernandez†, Joel J. Sohn, and Chris T. Amemiya*. *Current Biology,* 2015. **25**(7), 897–900

→ The first demonstration of chitin synthesis in vertebrates. This research had broad implications on policies for the use of pesticides. It is also often discussed for the serendipitous finding of sub-micrometric plastic pieces in the mucosa of sea animals Huffington Post.

Manufacturing of large-scale objects using biodegradable chitosan bioplastic
Javier G. Fernandez and Donald E. Ingber*. *Macromolecular Materials and Engineering*, 2014. 229**(8)**, 932-938

→ Most accessed article of the journal from March to May 2014. Cover of the June 2014 issue. The first example of a material bio-inspired and engineered at a molecular scale and used in large scale manufacture. The process to fabricate with the second most abundant organic material on earth was internationally praised because of its suitability for sustainable development (Science/AAAS, The Guardian, Huffington Post)

Unexpected strength and toughness in composites inspired by insect cuticle
Javier G. Fernandez and Donald E. Ingber. *Advanced Materials*, 2012. **24**(4), 480-484

→ Cover of the issue. It was the most-read article of the journal in December 2011 (one month before its actual publication). The impact of the findings in a new generation of bio-inspired sustainable materials was highlighted by international media such as Scientific American, The National Geographic or The Daily Mail

Simultaneous (bio)chemical and topographical patterning on curved surfaces using biocompatible sacrificial molds
Javier G. Fernandez*, Josep Samitier, and Christopher A. Mills. *Journal of Biomedical Materials Research Part A*, 2011. **98A**, 229-234

Micro-masonry: Construction of 3D Structures by Microscale Self-Assembly
Javier G. Fernandez, Ali Khademhosseini. *Advanced Materials*, 2010. **22**(23), 2538-2541

→ Described as a "breakthrough in tissue engineering" and "incredibly elegant solution" by specialized and social publications such as CNET, New Scientist, or The New York Times.

Complex, Micro-structured, 3D Surfaces Using Chitosan Biopolymer
Javier G. Fernandez*, Christopher A. Mills and Josep Samitier. *Small*, 2009. **5**(5), 614 - 620

Micro and Nanostructuring of Free-Standing, Biodegradable, Thin Sheets of Chitosan via Soft Lithography
Javier G. Fernandez, Christopher A. Mills, and Josep Samitier. *Journal of Biomedical Materials Research Part A*, 2008. **85**(1), 242-247

Forced Soft Lithography (FSL): Production of micro- and nano-structures in thin freestanding sheets of biopolymer
Javier G. Fernandez*, Christopher A. Mills, Mateu Pla-Roca, and Josep Samitier. *Advanced Materials*, 2007. **19**(21), 3696-3701

All-polymer microfluidic particle size sorter for biomedical applications
Javier G. Fernandez*, Christopher A. Mills, R. Rodríguez, G. Gomila, and J. Samitier. *Physica Status Solidi A*, 2007. **203**(6), 1476-1480

→ Chosen as an example of "*outstanding design of a single layer of geometric patterning providing meaningful functionality*" in the reference book "Microfabrication for Microfluidics" (Artech House, 2010)

Other relevant contributions for ICREA (second/corresponding author)

(Selected publications with a primary intellectual and ideation contribution relevant to the proposal and with Catalan coauthors)

Hierarchical Colorful Structures by Three-dimensional Printing of Inverse Opals
Hemant Kumar Raut, Hao Wang, Qifeng Ruan, Hongtao Wang, Javier G. Fernandez*, Joel K.W. Yang*. *Nano Letters*, 2021. **21**(20), 8602-8608

Fiber-reinforced composite manufacturing for passive actuators
Dhileep Kumar Jayashankar, Sachin Sean Gupta, Naresh D. Sanandiya, Javier G. Fernandez*, Kenneth Tracy*. *The International Journal of Advanced Manufacturing Technology*, 2020. **109**, 1493-1509

The use of high glass temperature polymers in the production of transparent, structured surfaces using nanoimprint lithography

Christopher A. Mills*, Javier G. Fernandez, Abdelhamid Errachid, and Josep Samitier. *Microelectronic Engineering*, 2008. **85**(9), 1897-1901

Directional alignment of MG63 cells on polymer surfaces containing point microstructures
Christopher A. Mills*, Javier G. Fernandez, Elena Martinez, Miriam Funes, Elisabeth Engel, A. Errachid, Josep Planell, and Josep Samitier. *Small*, 2007. **3**(5), 871-879

Micro/nanopatterning of proteins via contact printing using high aspect ratio PMMA stamps and nanoimprint apparatus
Mateu Pla-Roca*, Javier G. Fernandez, Christopher A. Mills*, E. Martinez, Josep Samitier. *Langmuir*, 2007. **23**, 8614-8618

Reviews and Book chapters

Extracellular Matrix Mechanobiology in Cancer Cell Migration *(Review)*
Jyothsna Vasudevan, Javier G. Fernandez, Lim Chwee Teck*. *Acta Biomaterialia*, 2023. **163**, 351-364

Biomaterials for mimicking and modelling tumor micro-environment *(Book Chapter)*
Rupambika Das, Javier G. Fernandez*. *Advances in experimental medicine and biology*, 2022. **1379**, 139-170.

Cellulosic Biocomposites for Sustainable Manufacturing *(Book Chapter)*
Stylianos Dritsas, Yadunund Vijay, Samuel Halim, Ryan Teo, Naresh Sanandiya, Javier G. Fernandez*. *Fabricate 2020*. UCL Press, 2020 (ISBN: 9781787358119)

Bioinspired chitinous material solutions for environmental sustainability and medicine. *(Review)*
Javier G. Fernandez and Donald E. Ingber*. *Advanced Functional Materials*, 2013. **23**(36), 4454-4466

Microscale Biomaterials for Tissue Engineering *(Book Chapter)*
Ian Wheeldon†, Javier G. Fernandez†, Hojae Bae, Hirokazu Kaji, and Ali Khademhosseini*. *Biomaterials for Tissue Engineering: A Review of the Past and Future Trends*. Springer/Nature, 2011 (ISBN: 978-3-7091-0384-5)

Conference papers

(Selected peer-reviewed leading contributions, full articles only, without abstracts)

Sustainable Rapid Prototyping with Fungus-like Adhesive Materials
Stylianos Dritsas, Jian Li Hoo, Javier G. Fernandez*. Proceedings of the 27th CAADRIA Conference, 2022, 263-72

3D printing passively actuated dynamic trusses
Dhileep Kumar Jayashankar, Sachin Sean Gupta, Javier G. Fernandez*, Kenneth Tracy*. Materials Today: Proceedings, 2022, **70**, 678-686

Improving the geometric accuracy in large-scale additive manufacturing of fungus-like adhesive materials
Jian Li Hoo, Stylianos Dritsas, Javier G. Fernandez*. Materials Today: Proceedings, 2022, **70**, 603-610

Towards sustainable additive manufacturing using Fungus-like adhesive materials
Stylianos Dritsas, Javier G. Fernandez*. Materials Today: Proceedings, 2022, **70**, 418-424

Additive Manufacturing with Natural Composites-From material intelligence to informed digital fabrication
S Dritsas, Y Vijay, R Teo, S Halim, N Sanandiya, Javier G. Fernandez*. *CUMINCAD*, 2019, 263-272

Prototyping of Chitosan-Based Shape-Changing Structures

Sachin Sean Gupta, Dhileep Kumar Jayashankar, Naresh D Sanandiya, Javier G Fernandez, Kenneth Tracy*. *CUMINCAD*, 2019, 441-450

An Additive and Subtractive Process for Manufacturing with Natural Composites
Stylianos Dritsas, Yadunund Vijay, Marina Dimopoulou, Naresh Sanadiya, Javier G. Fernandez*. *Robotic Fabrication in Architecture, Art and Design*, 2018, 181-191

Control of Process Settings for Large-Scale Additive Manufacturing With Sustainable Natural Composites
Yadunund Vijay, Naresh Sanadiya, Stylianos Dritsas, Javier G. Fernandez*. *ASME 2018 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference*, 2018, 85994

Work under evaluation (Submitted):

Stronger when wet: Water-resistant chitinous objects via zero-waste coordination with metal ions
Akshayakumar Kompa, Javier G. Fernandez*

3D printed tumor-on-chip platform with photopatterned cell-laden hydrogels to study chemotaxis of breast cancer cells
Jyothsna Vasudevan, Lim Chwee Teck, Javier G. Fernandez*

Bioinspired Chito-Cellulosic Composites: A Sustainable, 3D-Printable Alternative to Polyurethane Foam Insulation
Ajay Kumar, Shiwei Ng, Yung Boon Chong, Heow Pueh Lee, Stylianos Dritsas, Javier G. Fernandez*

Documentaries (IMDb personal page)

Des emballages emballants *("The exciting packaging")*
Association relative à la télévision européenne (ARTE), FutureMag, 2015. *European release (in French)*

Bionic – The best ideas from nature: Arms race
British Broadcasting Corporation (BBC), Oxford Scientific Films and Terra Mater Factual Studios, 2012. (English and German)

**Corresponding Author*
†Equal contributions

Patents

A High Strength Chitin Composite Material and Method of Making
Javier G. Fernandez, Donald E. Ingber
US Patent 9,433,698

Fabrication of 3-D articles with chitosan
Javier G. Fernandez, Donald E. Ingber
US 2013/028847

Method for attaching organic and inorganic components to biological materials
Javier G. Fernandez, Donald E. Ingber
US 61/604,855

Methods and devices for forming a coating layer
Javier G. Fernandez, Christopher Ding, Sujata K. Bhatia, Donald E. Ingber
US 61/748,882

Apparatus for large-scale additive manufacturing and a material for manufacturing

Javier G. Fernandez, Stylianos Dritsas
US Patent 11,820,077

A cellulosic composite incorporating a biologically active component or living organism
Javier G. Fernandez
Singapore Application Number 10201911744R

A biocompatible and edible material with tunable stiffness and texture
Jyothsna Vasudevan, Lim Chwee Teck, Javier G. Fernandez
Singapore Application Number 10202008415Q

A biological approach to metalworking based on polymeric colloids and composites
Ng Shiwei, Ng Benjamin, Robert E. Simpson, Javier G. Fernandez
Singapore Application Number 10202251249F

A water-resistant material and its methods of fabrication
Akshayakumar Kompa, Javier G. Fernandez
Singapore Application number S61019099

Mentorship and teaching experience

Teaching

Undergraduate Courses

"Digital Biomimetics: Sustainable Materials and Manufacturing" (30.316) (*Course Leader*)
Singapore University of Technology and Design (SUTD), 2019-Ongoing

"Introduction to Design" (03.007)
Singapore University of Technology and Design (SUTD), 2021-2023

"Capstone I & II" (01.400 & 01.401)
Singapore University of Technology and Design (SUTD), 2017-Ongoing

"Modelling the Systems World" (10.007)
Singapore University of Technology and Design (SUTD), 2018-2021

"Advanced Math II" (10.004)
Singapore University of Technology and Design (SUTD), 2015-2018

"Advanced Math I" (10.001)
Singapore University of Technology and Design (SUTD), 2015-2019

"Introduction to Engineering Sciences" (ES1)
School of Engineering Sciences (SEAS), Harvard University, 2013
"Optisk tecnik" (Teaching Assistant)
Lund University, 2004

Graduate Courses and Seminars

"Computational Science & Engineering" (30.504) (*Course Leader*)
Singapore University of Technology and Design (SUTD), 2022-Ongoing

"Research Projects" (30.580) *(Course/Programme Leader)*
Engineering and Product Development (EPD), SUTD, 2016-2017

*"*Introducción a la problemática de las basuras marinas*"* (52388)
Universidad Politécnica de Cartagena, 2017

"Drug Delivery" (ENSC 221)
School of Engineering Sciences (SEAS), Harvard University, 2014

"Tissue Engineering for Clinical Applications" (ENSC E-132)
School of Engineering Sciences (SEAS), Harvard University, 2013

Graduate research advisor

PhD
(As of 2023, +83% of the Ph.D. graduates in engineering are females)

- "Cell and drug delivery using geometrical control of bioprinted scaffolds"
Revathi Ravindran, SUTD (2023, ongoing)

- "A bioinspired approach to general manufacturing based on bioconversion"
Ajay Kumar, SUTD (2022, ongoing)

- "Study And Development Of Circular Manufacture Models Based On Bioinspired Materials"
Shiwei Ng, SUTD-NUS (2018-2023)

- ***"Modelling Cancer Cell Migration in Tumor-on-Chip Platforms and Future Integration with Machine Intelligence"***
Jyothsna Vasudevan, SUTD-NUS (2016-2021)

- ***"Guiding Controlled Stem Cell Differentiation And Preservation For Tissue Engineering Application"***
Rupambika Das, SUTD (2017-2020)

- ***"Use Of Microorganisms In Autonomous Swarms Of Microrobots For Monitoring Applications"***
Ashaa Preyadharishini Shunmugam, SUTD (2017-2021)

- ***"Tough and Impact-Resistant Helicoidal Electrospun Fiber-Reinforced Composites"***
Dr. Komal Agarwal, SUTD (2016-2020) Co-directed with Prof. Avinash Baji (University of Melbourne, Australia)

- ***"Fabrication and Optimization of Thermoresponsive Janus Membranes to Enhance Liquid and Vapor Transmission"***
Dr. Anupama Sargur Ranganath, SUTD (2014-2018) Co-directed with Prof. Avinash Baji (University of Melbourne, Australia).

MsC

- **"Resilient production of furniture based on bioinspired manufacturing"**
Hu Zi Ying Cherie, SUTD (2022-2024)

- **"Study of Relationships Between Particle Geometry and Mechanical Properties in Organic-Metal Composites"**
Ng Guan Zhi Benjamin, SUTD (2019-2021)

- **"*Development and Optimization of a Sustainable, Large-scale & Rapid Additive Manufacturing Process using Natural Materials.*"**
Yadunund Vijay, SUTD-MIT (2016-2018)
SUTD Best Master's Thesis '18 award

- ***"Development and Design of a Sprayable Chitosan-Based Tissue Adhesive"***
Suneil Seetharam, Harvard University (2013-2014)
Master's thesis co-directed by Sujata Bathia and Javier G. Fernandez
Harvard Dean's Outstanding Master's Thesis '13 award.

- **"*Double Spray Device for Delivery of Tissue Adhesive*"**
Christopher Ding, Harvard University (2012-2013)
Master's thesis co-directed by Sujata Bathia and Javier G. Fernandez

- ***"A Bacterial Spore Based Hygrovoltaic Generator"***
Tejal Naik, Harvard University (2011-2012)
Master's thesis co-directed by Kenny Roberts and Javier G. Fernandez

- Mentor of +100 undergraduate student projects in Medical Devices (MIT and SUTD), Materials Sciences (SUTD), Robotics (SUTD), and Biotechnology (SUTD)

Workshops and conferences

(Only personal contributions. Not including contributions by group members)

Invited talks *(Without contributed talks)*

- Materials Research Society (MRS) fall meeting (Boston 2024, USA)
Invited keynote speaker in Biological and Bioinspired Polymers *(Accepted invitation)*
- Materials Research Society of Singapore (Singapore 2022)
- Global Space and Technology Convention (GSTC) (Singapore 2022)
- IEEE-NanoMed (Taiwan 2021)
- Institute of Physics Singapore (Singapore 2021)
- SGInnovate (Singapore 2021)
- Interzum (Cologne 2021, Germany)
- 12th Stem Cell Society Singapore Symposium (Singapore 2020)
- Bioengineering for future and precision Medicine (Barcelona 2020, Spain)
- IMX Seminar Series (Lausanne 2020, Switzerland)
Invited talk hosted by Prof Harm-Anton Klok
- One North Festival (Singapore 2019)
Key speaker for Sustainable Design
- Ecoprosperity 2019 (Singapore 2019)
Invited speaker as scientist and innovator
- SUTD-MIT International Design Center (IDC) Symposium (Singapore 2018)
Key speaker for Sustainable Design
- National Additive Manufacturing Innovation Cluster (NAMIC) (Singapore 2017)
Opening talk on Emerging Applications
- Mechanobiology Institute (MBI) (Singapore 2017)
Invited talk hosted by Prof Yusuke Toyama
- Launch Nordic Forum (Malmö 2016, Sweden)
Invited speaker as a selected innovator
- Singapore Healthcare Management (Singapore 2016)
- Department of Biological Sciences, NUS (Singapore 2016)
Invited talk hosted by Prof Antonia Monteiro
- Wearable Smart Clothing (Singapore 2016)
Lee Kuan Yew Centre for Innovative Cities
- EmTech Asia 2016 (Singapore 2016)
Invited speaker as TR35 Innovator under 35
- NUS Biomedical Engineering Department (Singapore 2015)
Invited talk hosted by Prof Lim Chwee Teck
- La Casa Encendida (Madrid 2015, Spain)
Invited expert (talk and discussion) on plastics, oceans, and development.
- Institute for Bioengineering of Catalonia (Barcelona 2015, Spain)
Invited talk hosted by Prof Josep Samitier
- United Nations World Innovation Summit (Boston 2012, USA)
Invited talk and host of the discussion in Bioinspired Engineering
- Harvard Business School (Boston 2011, USA)
Invited talk hosted by Prof. Woody Yang for the course "*Commercializing Science.*"
"The role of Shrilk and other biomaterials in emerging technologies."
- Japan's GCOE Program research (Boston 2011, USA)
Invited talk hosted by the Japan Society for the Promotion of Science

"Bioinspired Materials: Shrilk case study."

- Harvard University (Boston 2011, USA)

Invited talk hosted by the School of Engineering and Applied Sciences

"Shrilk: A material inspired by insect cuticle."

- Technological University of Munich (Munich 2010, Germany)

Invited talk hosted by the Department of Molecular and Cellular Biophysics

"Microfabrication technologies and materials for tissue engineering."

- Ludwig Maximilians Universität (Munich 2010, Germany)

Invited talk hosted by the Soft Condensed Matter Group
"Chitosan and mesoscale self-assembly: Approaches for 3D microfabrication in biomedicine."

- Wyss Institute (Boston 2010, USA)

Invited talk hosted by Prof. Donald E. Ingber
"3D Microfabrication for Biomedicine based on chitosan and mesoscale self-assembly."

- Massachusetts Institute of Technology (Boston 2009, USA)

Invited talk hosted by the Department of Health Sciences and Technology
"From the crab to the lab: Studies about micro and nanofabrication with chitosan."

Organizer

- International Conference on Materials for Humanity (MRS) (Singapore 2022)

Chair of Sustainable Materials and Development

- The 17th International Conference on Biomedical Engineering (Singapore 2019)

Organizing Committee Member

- The 16th International Conference on Biomedical Engineering (Singapore 2016)

Member of the Local Scientific Committee

Participation in scientific journals and societies

- Invited reviewer of:
  - Acta Biomaterialia *(Elsevier)*
  - Advanced Functional Materials *(WILEY-VCH)*
  - Advanced Healthcare Materials *(WILEY-VCH)*
  - Advanced Materials *(WILEY-VCH)*
  - Advanced Science *(WILEY-VCH)*
  - APL Materials (*American Institute of Physics*)
  - Applied Polymer Materials (*American Chemical Society*)
  - BioFabrication *(IOP Publishing)*
  - Biomaterials *(Elsevier*)
  - Carbohydrate Polymers *(Elsevier)*
  - Cell Adhesion & Migration *(Landes Bioscience)*
  - ChemNanoMat *(WILEY-VCH)*
  - Composites (*Elsevier*)
  - International Journal of Nanomedicine *(Taylor and Francis Group)*
  - Journal of Biotechnology & Biomaterials *(OMICS Publishing Group)*
  - Journal of Cleaner Production *(Elsevier)*
  - Journal of Mechanical Design (*American Society of Mechanical Engineers*)
  - Journal of the Royal Society Interface (*The Royal Society*)
  - Journal of Visualized Experiments (JoVE) (*Jove Corp*)
  - Materials Today Chemistry (*Elsevier*)
  - Nanotechnology, Science, and Applications *(Dove Medical Press)*
  - Nano Energy (*Elsevier*)
  - Nature Communications (N*ature Publishing Group*)
  - PLoS ONE (*Public Library of Science*)
  - Robotics and Autonomous Systems (*Elsevier*)
  - Scientific Reports (*Nature Publishing Group*)
  - Trends in Biotechnology (*Cell Press*)

- Scientific/business advisor of:
  European Research Council (ERC – Consolidator Grant)
  SingHealth Foundation (SHF)
  Singapore Stem Cell Consortium (SSCC)
  The Boston Consulting Group (BCG)

Others

Explanations of my work in general and specialized media:

Personal Interviews (International media)

- **Tech Briefs (NASA)**

"Here's an Idea: A Bug-Inspired Building Material for Mars" Billy Hurley, 2020 (Radio Interview)

- **3Dprinting.com**

"Exclusive Interview: Chitonous Hopes to Use Ubiquitous Biological Polymers for Manufacturing" Joris Peels, 2019 (Magazine Interview)

- **Engineering.com**

"The Significance of Completely Biodegradable 3D-Printed Plastic" Michael Molitch-Hou, 2018 (Magazine Interview)

- **Forum Network**

"Shrilk" Derrik Sullivan, 2017 (Video Interview)

- **Southern California Public Radio (NPR)**

"Shrimp shells could make the green plastic of the future" Meghan McCarty, 2014 (Radio Interview)

- **Canadian Broadcasting Corporation (CBC)**

"Food Waste" Torah Kachur, 2014 (Radio Interview)

- **Fox News**

"Harvard researchers develop bioplastic" Ashley Dvorkin, 2014 (TV Interview)

- **Science for the Public (WGBH)**

"*Replacing Plastic*" Yvonne Stapp, 2014 (TV Interview)

- **BBC Radio 4**

"*The End of Plastic*" Tom Heap, 2013 (Radio Interview)

- **BBC**

"Genius of Nature" John Capener, 2012 (Documentary)

Explanations of my work *(International leading media only)*

- **CNN,** Katie Hunt

"This is how we should build on Mars, scientists say"

- **The Daily Mail,** Jonathan Chadwick

*"*Future Mars habitats*"*

- **Huffington Post,** Lynne Peeples

"Surprise Finding Heightens Concern Over Tiny Bits Of Plastic Polluting Our Oceans"

- **Discovery Channel,** Carin Bondar

"Can We Make Plastic from Shrimp?"

- **Business Insider,** Douglas Main

"Biodegradable Plastic"

- **The Guardian,** Ian Sample

"Five wonder materials that could change the world."

- **Scientific American,** Steven Ashley, and Larry Greenemeier

"9 Materials That Will Change Manufacturing"

- **Scientific American,** Cynthia Graber
"Insect Cuticle Inspires New Material"

- **National Geographic Magazine,** Ann Williams
"Super Materials"

- **The Daily Mail,** Rob Waugh
"Shrilk' is a lab-grown version of insect armor which could replace plastics"

- **Science Daily,** Dan Hogan
"Inspired by Insect Cuticle, Scientists Develop Material That's Tough and Strong"

- **Fast Company,** Nidhi Subbaraman
"Insect-Inspired Material That Could Solve Our Plastic Problem"

- **CNET,** Elizabeth Armstrong Moore
"Breakthrough in tissue engineering: 'Bio-Legos'"

- **New Scientist,** Wendy Wolfson
"*'Human Lego' may one day build artificial organs.*"

- **The New York Times,** Ben Schott
"*Micromasonry & Biological Lego*"

- **MIT News,** Anne Trafton
"Building organs block by block."

In Spanish media (Selected for ICREA, no particular criteria)

- **La Ser**
"El Faro" Mara Torres, 2023 (Radio Interview)

- **Europa Press**
"El primer vuelo de la mariposa inspira una nueva fuente de energía", 2023

- **Radio Nacional de España**
"Bioplásticos y quitosano" Mamen Asencio, 2023 (Radio Interview)

- **ABC**,
"FLAM, la alternativa al plástico se esconde en la naturaleza" Alexia Columba Jerez, 2022

- **VozPopuli**
"Polvo de langostas para construir en Marte" Antonio Martínez Ron, 2020 (Magazine Interview)

- **El Pais**
"Serrín y gambas para imprimir a gran escala" Nacho Sanchez, 2019 (Magazine Interview)

- **ONE**
"¿Fabricaremos con materiales inteligentes que se repararán solos? Javier Gómez responde" Selena Sheikh, 2016 (Video Interview)

- **El Mundo**
"El creador español de Shrilk, el plástico del futuro, se va a Singapur" David Guerrero, 2015 (Magazine Interview)

- **TV3 (Els Matins)**
"El quitosan podria substituir el plàstic" Helena Garcia Melero, 2015 (TV Interview)

- **La Cope**
"El quitosano, un material biodegradable que puede sustituir al plástico" Roberto Pablo and Lartaun de Azumendi, 2015 (Radio Interview)

- **El Pais**
"El adiós al plástico está en el caparazón de un insecto" Carlos Betriu, 2015 (Magazine Interview)

- **La Ser**
"El final del plástico está en los insectos y crustáceos" Carles Francino, 2015 (Radio Interview)

APPENDIX: Three personal achievements (In compliance with SFDORA criteria)

A generalizable approach to sustainability (Research)
As a postdoctoral researcher working at Harvard University, I developed an initially simple principle that later became fundamental in my work: Biological molecules and how they aggregate to form structures are inseparable aspects of biomaterials. Therefore, if we want to incorporate natural resources into industrial processes, it is not enough to possess the components; we must also reproduce the way in which they are designed. This hypothesis, which was first demonstrated by reproducing in an artificial replica the native synergies in the insect cuticle (i.e., Shrilk) and later applied on an industrial scale with Fungal-Like Adhesive Materials, offered a new paradigm for the development of sustainable materials via a bioinspired perspective, one based on the control and reproduction of the principles of biological materials by using their own components. These bioinspired materials are based on the most ubiquitous organic components in the Earth's crust; more importantly, they are produced and degraded in large quantities in every ecosystem. Such characteristics enable the production of models where the materials are obtained, processed, and degraded within closed regions and without the need to either transport components or develop synthesis and recovery systems.
My achievements in bioinspired manufacturing represent a unique technology capable of competing with plastics in terms of the versatility of its mechanical properties, cost, and manufacturing capacity. In addition, it offers an economically competitive path to sustainability for all countries, regardless of their economic development. As a result, I have been characterized as "the most relevant young researcher in materials science" (Bayer Foundation), while my work has been lauded as "the future of manufacturing" (Scientific American) and "the missing piece of the circular economy" (Engineering.com). The enormous potential of my research was proven five years ago when I demonstrated a bioinspired approach to mass manufacturing using ubiquitous polysaccharides as part of existing ecosystems. Last year, I validated how this result enables the production of extremely efficient circular manufacturing in every ecosystem, including highly urban environments and even human settlements on other planets.

Article about my research: https://new.engineering.com/story/the-significance-of-completely-biodegradable-3d-printed-plastic
Video explaining my research: https://www.youtube.com/watch?v=S6_vaI1_LNQ

Rethinking research and education (Leadership)
My professional career is strongly linked to the foundation and development of new research and educational institutions—which explains the publication gaps during transitions into new positions. I was in the first cohort of Ph.D. students at the Institute of Bioengineering of Barcelona; therefore, my first tasks included buying my desk and setting up my research environment in an empty lab. Despite the related challenges, three and a half years later, my thesis on biomedical uses of chitinous polymers was awarded the best thesis at the University of Barcelona. During that time, I also started my Master of Social and Cultural Anthropology; however, it was interrupted when I finished my thesis and moved to MIT as a postdoc.
While in the United States, I was personally recruited by Don Ingber, founding director of the —then-newly created— Wyss Institute for Bioinspired Engineering, to lead a line in bio-inspired materials for sustainable and medical engineering. During my five years with the Wyss Institute, we grew from a 25-person organization on a small floor to more than 800 people across two campuses. The research line on bio-inspired materials for sustainability became one of the first great successes of the institute.
In 2015, I was recruited to start and develop the Singapore University of Technology and Design (SUTD)—MIT's most significant overseas educational project. As a founder and an academic member of the SUTD, I have been deeply involved in developing, deploying, and refining its academic and research programs in engineering and design. During the last seven years, I have worked on all aspects of establishing the institution, from the design of the labs to the continuous rethinking of the academic program. This rare and extremely valuable experience included, for example, the unique integration of the humanities, arts, and social sciences with the SUTD's multi-dimensional engineering and architecture programs and the development of the first course on sustainable materials and design. The SUTD is considered one of the best-emerging engineering schools in the world.

SUTD: https://sutd.edu.sg/About-Us/News-and-Events/News/2018-(3)/3-(92)/SUTD-named-one-of-top-emerging-engineering-school

Closing the loop (Entrepreneurship)
The World Bank Group recently confirmed that waste is spiraling out of control globally. Current recovery processes, which are connected to uncontrolled production, are technologically unfeasible for developing countries. In developed countries, these processes are increasingly unaffordable and include oversized waste management systems, resulting in overwhelming ecological and economic issues. I founded Chitonous Pte. Ltd. to foster a paradigm shift after demonstrating a feasible, low-cost, and generalizable approach to circular manufacturing in urban environments.
Chitonous Pte. Ltd. centers on developing global solutions for circular manufacturing based on biological materials and sourcing from urban organic refuse. It has been described as "the company that could fundamentally change how we design and consume materials for manufacturing." While sustainable solutions usually focus on recovery/reuse strategies for developed countries, Chitonous's solutions center on technology applicable globally across countries with different levels of development. The current applications of Chitonous's business range from furniture to automotive parts and packaging.
In addition to Chitonous, our lab has recently spun out another company; this one focused on technology to evaluate the health of ecosystems based on the behavior of the waterborne microorganisms that inhabit them. The technology employed adapts concepts and tools developed for cancer diagnostics to extract hidden behavior in microorganisms using computer vision and machine learning.

Article about Chitonous Pte. Ltd.: https://3dprint.com/258923/exclusive-interview-chitonous-hopes-to-use-ubiquitous-biological-polymers-for-manufacturing/