

3D Photovoltaics, E. Alarcón Lladó (2017-2022)

Biography



Prof. Esther Alarcón Lladó is the group leader of the 3DPV group at NWO-I AMOLF and professor of nanoelectrochemistry at the University of Amsterdam. After having worked as a postdoc at top international groups at Lawrence Berkely Laboratory (LBNL) and École Polytechnique Fédérale de Lausanne (EPFL), she founded the 3DPV group in 2016.

Alarcon Llado has a strong track record in the development of new materials and energy conversion principles for sustainable energy generation with a unique complimentary approach based on photonics, spectroscopy and (photo)electro-chemistry. She is renowned for her work on photonic waveguiding in solar cells. Apart from the many contributions on the field of nanowire PV, she has introduced hyperuniform disorder nanopatterning as an efficient light management platform for thin film PV and demonstrated the strongest

light absorption in thin c-Si. Additionally, her group is known for the high degree of spatio-temporal control over ions/ion complexes in solution and their chemistry.

Within this framework, she has developed highly promising synthesis pathways for photovoltaic materials (III V, perovskites and metals) in line with circular chemistry, as it minimizes raw material and energy consumption.

Her group has developed distinctive in-situ/operando scanning probe microscopes for the investigation of dynamic nanoscale phenomena at electrified solid-solid and solid-liquid interfaces. The international visibility of Alarcón Lladó is evidenced by the long list (>30) of invited talks at (inter)national conferences, symposia and schools. She was awarded a Fulbright and a Marie Curie fellowship for her postdoctoral studies at LBNL and at EPFL. She was later awarded the Ambizione Energy grant (the Swiss equivalent to a Veni/Vidi grant, 800 k€). Her group is part of several national and European projects/consortia, and she is the leader in the national consortium on light-driven chemistry, including the industrial partnership with 4 major corporations. Alarcón Lladó is member of the advisory committee of the Dutch Physics Council, the scientific advisory committee of the National Growth Fund program on photonics, and editorial board member of the scientific journals *ACS Applied Optical Materials*, *Solar Energy Materials and Solar Cells*, and *Frontiers in Photonics*. She is also actively engaged in diversity and inclusion discussions, with several contributions on female leadership programs and inclusivity in science events.

Group output 2017-2022

Peer reviewed Publications 2017-2022

2017

1. Dmitry Mikulik, Maria Ricci, Gozde Tutuncuoglu, Federico Matteini, Jelena Vukajlovic, Natasa Vulic, Esther Alarcon-Llado and Anna Fontcuberta i Morral, *Conductive-probe atomic force microscopy as a characterization tool for nanowire-based solar cells*, *Nano Energy* **41**, 566-572 (2017)
2. Rune Frederiksen, Gozde Tutuncuoglu, Federico Matteini, Karen L. Martinez, Anna Fontcuberta i Morral and Esther Alarcon-Llado, *Visual Understanding of Light Absorption and Waveguiding in Standing Nanowires with 3D Fluorescence Confocal Microscopy*, *ACS Photonics* **4**, 9: 2235–2241 (2017)

2018

1. S. Ardo, D. Fernandez Rivas, M.A. Modestino, V. Schulze Greiving, F.F. Abdi, E. Alarcón-Lladó, V. Artero, K. Ayers, C. Battaglia, J.P. Becker, D. Bederak, A. Berger, F. Buda, E. Chinello, B. Dam, V. Di Palma, T. Edvinsson, K. Fujii, H. Gardeniers, H. Geerlings, M. Hashemi Shabestari, S. Haussener, F. Houle, J. Huskens, B.D. James, K. Konrad, A. Kudo, P. Patil Kunturu, D. Lohse, B. Mei, E.L. Miller, G.F. Moore, J. Muller, K.L. Orchard, T.E. Rosser, F.H. Saadi, J.M. Schüttauf, B. Seger, S.W. Sheehan, W. A. Smith, J. Spurgeon, M.H. Tang, R. van de Krol, P.C.K. Vesborgag and P. Westerik, *Pathways to electrochemical solar-hydrogen technologies*, Energy Environ. Sci. **11**, 10: 2768-2783 (2018). **Green OA**

2019

1. F. Podjaski, D. Weber, S. Zhang, L. Diehl, R. Eger, V. Duppel, E. Alarcon-Llado, G. Richter, F. Haase, A. Fontcuberta i Morral, C. Scheu, B. V. Lotsch, *Rational strain engineering in layered oxides for Highly Efficient Hydrogen Evolution Catalysis in Acidic Media*, Nature Catalysis, doi:10.1038/s41929-019-0400-x (2019). **Green OA**
2. M. Aarts, E. Alarcon-Llado, *Directed nanoscale metal deposition by the local perturbation of charge screening at the solid-liquid interface*, Nanoscale **11**, 18619 (2019). **Gold OA**
3. N. Tavakoli, E. Alarcon-Llado, *Combining 1D and 2D waveguiding in Ultrathin GaAs NW/Si Tandem Solar Cell*, Optics Express **27**, A909 (2019). **Gold OA**

2020

1. E.C. Garnett, B. Ehrler, A. Polman and E. Alarcón-Lladó, *Photonics for Photovoltaics – advances and opportunities*, ACS Photonics **8**, (1), 61-70 (2020), **Hybrid OA**.
2. B. Ehrler, E. Alarcón-Lladó, S.W. Tabernig, T. Veeken, E.C. Garnett and A. Polman, *Photovoltaics Reaching for the Shockley–Queisser Limit*, ACS Energy Lett. **5**, (9), 3029-3033 (2020).
3. M. Valenti, Y. Bleijl, J.B. Portals, L.A. Muscarella, M. Aarts, F. Peiro, S. Estrade and E. Alarcón-Lladó, *Grain size control of crystalline III–V semiconductors at ambient conditions using electrochemically mediated growth*, J. Mater. Chem. A **8**, (5), 2752-2759 (2020), **Green OA**.

2021

1. G. Grimaldi, L. S. D. Antony, L. Helmbrecht, A. van der Weijden, S.W. van Dongen, I. Schuringa, J. Borchert, E. Alarcón-Lladó, W.L. Noorduin and B. Ehrler, *Microstructuring of 2D perovskites via ion-exchange fabrication*, Appl. Phys. Lett. **119**, (22), 223102: 1-8 (2021) **Hybrid OA**
2. M. Aarts, S. van Vliet, R. Bliem and E. Alarcón-Lladó, *Investigation of copper nanoscale electro-crystallization under directed and non-directed electrodeposition from dilute electrolytes*, CrystEngComm **23**, (20), 3648-3653 (2021)

2022

1. M. Aarts, W.Q. Boon, B. Cuénod, M. Dijkstra, R. van Roij and E. Alarcón-Lladó, *Ion Current Rectification and Long-Range Interference in Conical Silicon Micropores*, ACS Appl. Mater. Interfaces, (2022) **Hybrid OA**
2. N. Tavakoli, R. Spalding, A. Lambertz, P. Koppejan, G. Gkantounis, C. Wan, R. Röhrich, E. Kontoleta, A.F. Koenderink, R. Sapienza, M. Florescu and E. Alarcón-Lladó, *Over 65% Sunlight Absorption in a 1 μm Si Slab with Hyperuniform Texture*, ACS Photonics **9**, (4), 1206-1217 (2022) **Hybrid OA**
3. T. Veeken, B. Daiber, H. Agrawal, M. Aarts, E. Alarcón-Lladó, E.C. Garnett, B. Ehrler, J. van de Groep and A. Polman, *Directional quantum dot emission by soft-stamping on silicon Mie resonators*, Nanoscale Adv. **4**, (4), 1088-1097 (2022) **Gold OA**
4. M. Aarts, A. Reiser, R. Spolenak and E. Alarcón-Lladó, *Confined pulsed diffuse layer charging for nanoscale electrodeposition with an STM*, Nanoscale Adv. **4**, (4), 1182-1190 (2022) **Gold OA**

PhD theses

2021

1. N. Tavakoli, *Solar Canvas: Nanoscale light management for ultra-thin, semi-transparent, and colourful solar cells*, University of Amsterdam, 14/10/2021, Open Access
2. M. Aarts, *INTERPHASE On Nanofabrication and Electrical Double Layer Dynamics with Electrochemical Scanning Probes*, University of Amsterdam, 26/01/2021, Open Access

2022

1. S.W. Tabernig, *Charge Carrier Generation Management in Photovoltaics*, University of Amsterdam, 2022-12-08 Open Access

MSc theses

2017

1. G. Giuzio, *Growth and optical properties of MoS₂ nanostructures*, September 2017 Sapienza University
2. L. Canil, *Non-aqueous electrochemical synthesis of Silicon*, August 2017 Padua University

2018

1. Kolpakov, *Electrochemical Atomic Force Microscopy for the Direct Writing of metal nanocrystals*, July 2018, UvA
3. J. Ocana Pujol, *Morphologically induced strain on MoS₂ vertical flakes for hydrogen evolution reaction*, September 2018, UvA
4. S. Marsman, *In Operando Oxygen Evolution Imaging*, Oct 2018, UU

2019

1. D. van Poorten, *Enhanced light absorption in ultrathin-Si film using nanowire arrays as light couplers*, December 2019, UvA
2. Y. Bleiji, *Towards inexpensive manufacturing of nanostructure III-V semiconductors using electrochemical mediated growth*, June 2019, UvA
3. R. Rougoor, *Meniscus Confined Electrochemical Deposition for 3D micro-printing*, October 2019, UvA

2020

1. M. Wobben, *Electro-deposited indium for nanophotonics*, June 2020, UvA
2. P. Koppejan, *Theoretical and experimental efficiency estimates of ultra-thin, flexible silicon for photovoltaic cells*, June 2020, UvA

2021

1. Lambertz, *Hyperuniform disordered light trapping for ultra-thin solar cells using substrate conformal imprint lithography*, June 2021, UvA

2022

1. K. Schokking, *Fabrication of (FACs)Pb(IBr)₃ perovskite micro disks for whispering gallery mode lasing*, July 2022, UvA
2. H. Echelman, *Patterned Electrodeposition and Conversion of Lead Dioxide to 2D Perovskite*, July 2022, UvA

Invited lectures at international conferences and meetings

2017

declined invitations due to maternity leave and childcare:

1. 9th International Conference on Materials for Advanced Technologies, MRS, Singapore
2. Conference Multi-functional oxide nanomaterials: from design to advanced applications, Italy
3. 12th IEEE Nanotechnology Materials and Devices Conference (NMDC'2017), Singapore
4. EMN meeting on Nanowires, Dubrovnik, Croatia

2018

1. *Managing the solar spectrum at sub-wavelength scales: Nanowire enabled new PV concepts*, SPIE Optics+Photonics conference, San Diego, USA
2. *Managing the solar spectrum at sub-wavelength scales: Nanowire-enabled concepts for solar energy conversion*, Spanish Conference on Nanophotonics (CEN2018), San Sebastian, Spain
3. *Using Nanowires in Novel Device Concepts in Photovoltaics*, MRS Fall Meeting Tutorial, Boston, USA
4. *Managing the solar spectrum at sub-wavelength scales*, PhotonicsEvent2018, PhotonicsNL, Enschede, Netherlands

Others:

5. Workshop on Hyperuniformity and Local-Self Uniformity in Photonics, UK (*cancelled last minute due to sickness*)
6. International Conference on Nanoscience + Technology 2018 (ICN+T 2018) (presented by *M. Valenti as contributed talk*), Brno, Check Republic

2019

1. *The photonics of semiconductor nanostructures for new solar energy conversion concepts*, Winterschool IWEPNM, Kirchberg, Austria, March 9-16, 2019.
2. *Manipulating light and matter at the nanoscale*, International Conference of Quantum, Nonlinear and Nanophotonics'2019 (ICQNN), Sofia, Bulgaria, September 2-4, 2019.
3. *Photonics of semiconductor nanowires for new solar energy conversion concepts*, ACS Southwest-Rocky Mountain Regional Meeting, El Paso, TX, USA, November 13-16, 2019.
4. *Semiconductor nanowires for new PV concepts*, Focus session at Physics@Veldhoven 2019, Netherlands

2020

1. *Probing ion dynamics at the solid-liquid interface with an electrochemical force microscope*, Focus session at Physics@Veldhoven 2020, Netherlands
2. *Ultrathin efficient solar cells enabled by nanoscale architectures*, Advanced Photonics OSA 2020, Montreal, Canada (online)
3. *Nanostructures for solar energy: new device and fabrication concepts*, 2020 BIST Conference, Barcelona, Spain (online)
4. N. Tavakoli, oral contribution to SPIE Photonics Europe (France), 2020 (upgraded to **invited talk**)
5. *Manipulating light and matter at the nanoscale for next generation solar energy conversion devices*, MRS Fall Meeting 2020, Boston, USA (online)
6. Conference on Molecular Nanostructures 2020, Ascona, Switzerland (moved to October 2023 due to COVID19).
7. Compound Semiconductor Week 2020, Stockholm, Sweden (moved to May 2021 due to COVID19).

2021

1. *Electrochemical methods for functional nanostructure growth*, Compound Semiconductor Week 2021 (online), Stockholm, Sweden

2022

1. *Nanoelectrochemical methods for solar energy*, E-MRS Fall Meeting, Warsaw, Poland
2. *Advanced light trapping designs for solar applications*, Workshop on Disorder Correlated Media and their Applications, Florence, Italy
3. *Manipulating light and matter at the nanoscale*, Seminar at the NanoLund seminar series, University of Lund, Lund, Sweden

Awards & recognitions

2019

1. Best poster prize, Y. Bleiji, ANNIC2019 conference, Paris, France.

2020- 2021

none

2022

8. A. Lambertz, Best student talk, Alex Lambertz, SeeFuturePV 2022, Lausanne, Switzerland
9. M. Micali, Young researcher award, e-MRS Spring Meeting 2022 (online)

Academic teaching 2017-2022

2018

1. Guest lecture on “Nanomaterials for Solar Energy” within the Nanoscience Course of the AUC, Amsterdam (2018)

2019

1. Two-day course on “Using Semiconductor Nanostructures in Novel Device Concepts for Solar Energy (I) and (II)” within the Advanced Materials, Nanotechnology and Photonics Master track, Free University of Madrid (UAM) (2019)

2021

1. Y. Bleiji, Introduction to numerical simulations of cyclic voltammograms (oral), AMCEL lecture series (online), 2021.

2022

1. Teaching in the Photovoltaics course, master's program Advanced Materials Energy and Program, UvA (2018-2022)
1. Guest lecture on “Synthesis, processing and fabrication of materials for energy”, within the Materials Design and Circularity Master course, UvA (2021-2022)

Economic valorization

1. Industrial partnership with **Toyota Motor Europe** for developing new type of photoelectrochemical reactors (direct funding, 2022)
2. Industrial partnership with **BASF, Shell, Toyota, ExxonMobil, Delmic, DensSolutions**, for developing a new kind of catalytic reactors driven by light (KIC-Key Technologies, 2021)

3. Industrial partnership with **VDL, Hyet Solar, SALDtech, Roland Berger**, for developing roll-to-roll methods for perovskite tandem solar cell technologies (KIC-Solar, 2021)
4. Industrial partnership with **Nanonics**, scanning probe microscopy company, for developing electrochemical scanning probe 3D nano printing with integrated optical diagnostics (HTSM, 2019)
5. Dr. Marco Valenti in the group has been admitted to the **ACE-Incubator mentorship** program to explore the possibility of creating a company based on electrochemical plasmonic lattices as a new kind of electrochromic windows, 2019.