

# Mohammadreza Nematollahi (PhD)

XUV optics group, MESA+ Institute for Nanotechnology, University of Twente

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## RESEARCH AREAS

Thin film fabrication and metrology | materials physics | optical and semiconductor materials | EUV optics | physics of surfaces and interfaces | piezoelectric MEMS actuators | laser material interaction | solar cells

## RESEARCH EXPERIENCE

<b>Present</b> <b>Feb. 2017</b>	<b>Post-doctoral researcher</b> , Industrial Focus Group XUV Optics, MESA+ Institute for Nanotechnology, <b>University of Twente, Netherlands</b> <ul style="list-style-type: none"><li>Research on smart interactive mirrors for lithography at EUV wavelengths</li></ul> In this position, I fabricate piezoelectric films and demonstration devices and study their properties. Due to the nature of the work, I have direct contact and collaboration with the industrial partners at Carl ZEISS SMT and Solmates.
<b>Jan. 2017</b> <b>Oct. 2014</b>	<b>Post-doctoral researcher</b> , <b>Norwegian University of Science and Technology (NTNU), Norway</b> . <ul style="list-style-type: none"><li>Research on potential intermediate band materials: doped ZnS, Si, Cu<sub>2</sub>O, and reduced MoO<sub>3</sub></li></ul> In this position, I deposited and characterized semiconducting and metallic thin films, and fabricated solar cells. The outcomes were published in multiple conferences and over five journal papers.
<b>July 2016</b> <b>March 2016</b>	<b>Visiting researcher</b> , <b>Solar Energy Institute at Technical University of Madrid, Spain</b> <ul style="list-style-type: none"><li>Research on intermediate band solar cell based on Cr-doped ZnS</li></ul> During the research visit, I joined the group of Prof. Antonio Martí, the inventor of intermediate band solar cells. We investigated the voltage preservation and the two-photon effect in the solar cells that I fabricated at NTNU earlier in 2016. The outcomes were published in Sol. Energy Mater Sol. Cells journal.
<b>Oct. 2014</b> <b>Oct. 2010</b>	<b>Ph.D. fellow</b> , <b>Norwegian University of Science and Technology (NTNU), Norway</b> <ul style="list-style-type: none"><li>Research on structural, compositional, and optical properties of ZnS doped by Cr, Fe, and Al films as potential intermediate band materials</li></ul> My PhD project was focused on Cr-doped ZnS as a potential intermediate band material. I deposited undoped and Cr-doped ZnS films by pulsed laser deposition (PLD) and characterized the material by various metrology techniques.
<b>Feb 2010</b> <b>Jan 2009</b>	<b>M.Sc.</b> , <b>Sharif University of Technology (SUT), Iran</b> <ul style="list-style-type: none"><li>Research on the gasochromic response of mixed metal oxides</li></ul> I deposited nanostructured thin films of (WO <sub>3</sub> ) <sub>1-x</sub> (MeO) <sub>x</sub> (MeO= TiO <sub>2</sub> , MoO <sub>3</sub> , NiO; x=0.09 - 0.33) by PLD, and studied the coloration contrast, velocity, and reversibility of the samples.

## EDUCATION

<b>Oct. 2014</b> <b>Oct. 2010</b>	<b>Ph.D., Physics</b> , <b>Norwegian University of Science and Technology (NTNU), Norway</b> <b>Title:</b> Cr-doped ZnS for intermediate band solar cells <b>Supervisor:</b> Assoc. Prof. Turid Worren Reenaas <b>Co-supervisor:</b> Prof. Ursula Gibson <b>Assessment committee:</b> <b>i)</b> Prof. Marta Castillejo, <i>Instituto de Química Física Rocasolano, Spain</i> ; <b>ii)</b> Dr. Wladek Walukiewicz, <i>Lawrence Berkeley National Laboratory, USA</i> ; <b>iii)</b> Assoc. Prof. Fride Vullum-Bruer, <i>Dept. Materials Science and Engineering, NTNU, Norway</i>
<b>Feb. 2010</b> <b>Sep. 2007</b>	<b>M.Sc., Physics</b> , <b>Sharif University of Technology (SUT), Iran</b> Total GPA: 17.63/20 <b>Title:</b> The effect of metal oxides on gasochromic properties of WO <sub>3</sub> thin films formed by pulsed laser deposition <b>Supervisor:</b> Prof. Seyed Mohammad Mahdavi
<b>Sep. 2007</b> <b>Sep. 2003</b>	<b>B.Sc., Atomic Physics</b> , <b>Shiraz University (SU), Iran</b> Total GPA: 17.30/20

## SKILLS AND COMPETENCES

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- **Pulsed laser deposition (PLD):** Nearly ten years of experience in pulsed laser ablation and deposition of various semiconducting and oxide materials (PbZr<sub>1-x</sub>Ti<sub>x</sub>O<sub>3</sub>, LaNiO<sub>3</sub>, Si, ZnS, Cr doped ZnS, Al doped ZnO, MoOx, WO<sub>3</sub>, TiO<sub>2</sub>, NiO, and binary compound oxides)
- **Sputtering, thermal and e-beam evaporation:** Deposited metallic contact for devices
- **Surface and thin film metrology:** Scanning electron microscopy (**SEM**), atomic force microscopy (**AFM**), focused ion beam (**FIB**), **light microscopy**, and transmission electron microscopy (**TEM**) data analysis, X-ray diffraction (**XRD**), X-ray photoelectron spectroscopy (**XPS**), energy dispersive spectroscopy (**EDS**), **UV-VIS** optical spectroscopy, white light interferometer (**WLI**), conductivity measurement by **Van der Pauw** & circular transfer length methods (**CTLM**), **profilometer**, photoluminescence (**PL**), spectroscopic ellipsometry (**SE**), **Ferroelectric testing**, double beam interferometer (**DBLI**)
- **Photolithography** for device fabrication and packaging
- **Solar cell characterization:** Quantum efficiency (**QE**), **I-V** characteristics, electroluminescence (**EL**)
- Extensive working experience in **cleanroom** ISO 5 and ISO 7
- **Design of vacuum systems**, specifically pulsed laser deposition (two advanced PLD system at NTNU, and UT)
- **Software and computer skills:** CleWin, Gwyddion, MATLAB, Latex, Origin, Microsoft office

## LANGUAGE

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**English** (fluent); **Persian** (mother tongue); **Dutch** (B1 level); **Norwegian** (A2 level)

## ACADEMIC ACTIVITIES

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### (Co)supervising experience:

**Ph.D.:** Philip Lucke (2017-current), Katherine Inzani (2014-2016), Thomas Brakstad (2015-2016)

**M.Sc.:** Peter Kusterle, Carl P. Heimdal (2014); Benjamin Hope, Heidi Hauge (2015); Erling Hannaas (2016)

**Reviewer:** Solar Energy Materials & Solar Cells, ISSN: 0927-0248; Journal of applied physics ISSN: 1089-7550; Journal of Energy and Power Engineering ISSN:1934-8983

**Examiner:** Examiner/opponent on M.Sc. thesis

## TEACHING EXPERIENCE

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**Project instructor** (Spring 2018), for the course "Fundamentals of Materials", (B.Sc. level, UT)

**Guest lecturer** (21/09, 22/09, and 29/09/2016) "Solar Energy" / 6 lectures, for the course entitled "Energy and Environmental Physics" (TFY4300 – NTNU)

**Course coordinator/lecturer** (Fall 2015), "Energy and Environmental Physics" (M.Sc. level, TFY4300, NTNU)

Course content: The energy budget of the earth, radiation and the greenhouse effect, ozone and life, climate and weather, and climate change. Methods and the physical basis for exploitation of conventional (fossil fuels and nuclear energy) and renewable energy sources (solar water heating and solar thermal, photovoltaics, wind, bio-mass and bio-fuel, ocean waves, hydro-power, tidal and geothermal energy)

**Guest lecturer** (23/10/2015) "Solar Energy and Solar Cells" / 2 lectures, for the course entitled "Energifremtider og miljøvisjoner/ Energy and environmental visions" (EP0100 – NTNU)

**Guest lecturer** (28/01/2015) "High Efficiency Solar Cells" / 2 lectures

**Lab teacher** (Fall 2008, Spring and Fall 2009) "Modern Physics Laboratory", SUT, (rewrote lab brochure, gave short lectures and answered questions during lab sessions, prepared and graded the exams).

**Teaching assistant** (Spring 2006) "Intro to Physics for Engineering Students", SU, (Assignment coordinator)

## SELECTED COURSES

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- **Supervising PhD students**, UT, Netherlands (2 days – 2017)
- **Teaching training seminar**, NTNU, Norway (3 days – 2016)
- **Advanced Pulsed Laser Deposition of Complex Oxides**, UT, Netherlands (3 days – 2011)

### Selected degree courses:

- **Ph.D. (at NTNU):** Solar Photovoltaic and Nanostructures, Application of Symmetry Groups in Physics, Advanced Experimental Physics, Advanced Characterization Methods, Laser Processing and Pulsed laser Deposition
- **M.Sc. (at SUT):** Advanced Quantum Mechanics 1&2, Advanced Solid State Physics 1, Nanomaterial Synthesis Methods, Surface Physics, Electrodynamics (Jackson), Statistical Mechanics, Advanced Laboratory 1
- **Undergraduate (at SU):** Spectroscopy, Laser, Vacuum Technology, Solid State Physics 1, Quantum Mechanics 1 & 2, Electromagnetism 1 & 2, Classical Mechanics 1 & 2, Mathematical Physics 1&2

## HONOURS

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- **Ranked 49th**, among **7534** participants in the Nationwide Graduate Entrance Exam in Physics and Nanophysics branch (Spring 2007)
- **Ranked 1<sup>st</sup>**, among **15** admitted students in the field of Atomic Physics in 1<sup>st</sup> semester of academic year 2003-04 in the Physics Department at Shiraz University
- **Ranked 3<sup>rd</sup>**, among **52** admitted students in 1<sup>st</sup> semester of academic year 2003-04 in the Physics Department at Shiraz University
- **Admission to the School for Exceptional Talents of Iran (NODET)**(1996-2003)

## GRANTS

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- **112,500 NOK (~13,250 USD)** ; NorFab grant; for work in NTNU NanoLab cleanroom, (2016)
- **125,000 NOK (~14,700 USD)**; NorFab grant; for work in NTNU NanoLab cleanroom (2015)
- **15,000 NOK (~1800 USD)**; Norwegian PhD Network on Nanotechnology for Microsystems; travel grant (2014)
- **40,000 NOK (4,700 USD)**; Norwegian PhD Network on Nanotechnology for Microsystems; financial support for laboratory and processing expenses (2011)

## SELECTED PUBLICATIONS

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My publication list is available in: [Google Scholar](#), and [Cristin.no](#)

### Journal papers

- [M. Nematollahi](#), E. Lopez, I Ramiro, P. G. Linares, E. Antolin, I. Artacho, C. Tablero, E. Karhu, T.W. Reenaas, A. Marti, "Interpretation of photovoltaic performance of n-ZnO:Al/ZnS:Cr/p-GaP solar cell", *Solar Energy Materials & Solar Cells* 169, 56-60 (2017)
- M. Jorge, S. Cooil, M. T. Edmonds, L. Thomsen, [M. Nematollahi](#), F. Mazzola, J.W. Wells, "Accelerated ageing of molybdenum oxide" *Materials Research Express* 4, 115502 (2017)
- K. Inzani, [M. Nematollahi](#), F. Vullum-Bruer, T. Grandea, S. M. Selbach, "Electronic Properties of Reduced Molybdenum Oxides", *Physical Chemistry Chemical Physics* 19, 9232-9245 (2017)
- K. Inzani, [M. Nematollahi](#), S. M. Selbach, T. Grandea, F. Vullum-Bruer, "Progression of Reduction of MoO<sub>3</sub> Observed in Powders and Solution-Processed Films", *Thin Solid Films* 626, 94-103 (2017)
- T. Brakstad, B. R. Hope, [M. Nematollahi](#), M. Kildemo, N. J. Podraza, K. Ghimire, and T.W. Reenaas, "Ellipsometric study of the optical response of ZnS:Cr for PV applications", *Applied Surface Science* 421, 315-319 (2017)
- [M. Nematollahi](#), X. Yang, E. Seim., P.E. Vullum, R. Holmestad, U.J. Gibson, and T.W. Reenaas, "Compositional and structural properties of pulsed laser-deposited ZnS:Cr films", *Applied Physics A* 122, 84 (2016)
- F. Mazzola, [M. Nematollahi](#), Z. Li, S.P. Cooil, X. Yang, T.W. Reenaas, J.W. Wells, "Resonant photoemission spectroscopy for intermediate band materials", *Applied Physics Letters* 107, 192104 (2015)
- [M. Nematollahi](#), X. Yang, L.M.S Aas, Z. Ghadyani, M. Kildemo, U.J. Gibson, T.W. Reenaas, "Molecular beam and pulsed laser deposition of ZnS:Cr for intermediate band solar cells", *Solar Energy Materials & Solar Cells* 141, 322-330 (2015)
- [M. Nematollahi](#), X. Yang, U.J. Gibson, T.W. Reenaas, "Pulsed laser ablation and deposition of ZnS:Cr", *Thin Solid Films* 590, 28-32 (2015)
- N. Molland, Z. Ghadyani, E.A. Karhu, S. Poggio, [M. Nematollahi](#), M. Kildemo, T.W. Reenaas, J.J. BelBruno, U.J. Gibson, "Band-edge modification and mid-infrared absorption of co-deposited Fe<sub>x</sub>Zn<sub>1-x</sub>S thin films", *Optical Material Express* 5 (7), 1613-1620 (2015)
- A.M. Fyhn, X. Yang, [M. Nematollahi](#), J.C. Walmsley, U.J. Gibson, "Anodic electrodeposition of Ag<sub>1-x</sub>Cu<sub>x</sub>O microcrystals", *Journal of Solid State Electrochemistry* 18 (1), 13-18 (2014)

### Selected conference papers

- [M. Nematollahi](#), X. Yang, E. Seim, P.E. Vullum, R. Holmestad, U.J. Gibson, and T.W. Reenaas, "Highly Cr-doped ZnS for intermediate band solar cells", In proc. of 17<sup>th</sup> International Conference on II-VI Compounds (II-VI 2015), Paris, France (2015)
- [M. Nematollahi](#), X. Yang, U.J. Gibson, T.W. Reenaas, "XPS study of Cr:ZnS films", In proc. of 30<sup>th</sup> European Conference on Surface Science (ECOSS 30), Antalya, Turkey (2014)
- X. Yang, [M. Nematollahi](#), U.J. Gibson, T.W. Reenaas, "Cr-doped ZnS for intermediate band solar cells", In proc. of 39<sup>th</sup> IEEE Photovoltaic Specialist Conference (PVSC 39), Tampa, Florida, USA, (2013)

### Selected talks

- [M. Nematollahi](#), K. Inzani, F. Vullum-Bruer, T. Reenaas, "Molybdenum trioxide for use in solar cells", Norwegian Solar Cell Conference, Son, Norway, (2016)
- [M. Nematollahi](#), X. Yang, U.J. Gibson, T.W. Reenaas, "Recent progress in Cr:ZnS based intermediate band solar cells", 6<sup>th</sup> World Conference on Photovoltaic Energy Conversion (WCPEC-6), Kyoto, Japan, (2014).
- [M. Nematollahi](#), X. Yang, U.J. Gibson, T.W. Reenaas, "Bulk intermediate band solar cell based on Cr-doped ZnS", Norwegian Solar Cell Conference, Oppdal, Norway, (2013)