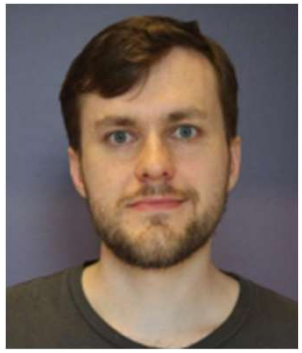
Materials physics - Who we are and what we do


Jaakko Akola


Raffaela Cabriolu


Ton van Helvoort


Randi Holmestad


Magnus Nord


Morten Kildemo


Turid Reenaas

Techniques and materials:

- Modelling and simulations of materials
- Thin film deposition and materials processing
- Optical characterization, polarimetry
- Transmission electron microscopy
- Programming, advanced data handling, machine learning

- Semiconductors, Metals and alloys, (Multi-)ferroic materials
- Nanoelectronics, Nanophotonics, Photovoltaics, ICT, catalysis…..

II-positions: Jesper Friis, Per Erik Vullum, David Zhe Gao
~4 technicians, ~20 postdocs/PhD students, ~15 MSc students.. **<u>All together approx. ~50 people</u>**

..via a project with us you can be part of one of these activities …

A project within our section offers:

- Choice of a project that fits your interests and background
- Training in operating advanced scientific equipment
- Or simulation and quantification software (theory/modelling)
- "Big data" processing using Python
- Concrete tasks - industry relevant projects available
- Weekly meetings with supervisor during the project
- In some cases:
  - Being part of a large, dynamic scientific consortium
  - Possibility in extending the project to MSc/PhD
  - Summer job / internship in Japan
  - Collaborations with other departments, international…

SUSOLTECH
The Norwegian Research Centre for Sustainable Solar Cell Technology

INSANE

ALLDESIGN

PhysMet

TEM Gemini Centre

http://www.ntnu.edu/geminicentre/tem

Prof. Jaakko Akola

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ALLDESIGN

NTNU Digital Transformation project for aluminum alloys

Main research interests:

- Atomistic and mesoscale simulations of metal alloys (DFT, Monte Carlo, phase field)
- DFT simulations of semiconductors
- Simulations (DFT) of catalytic reactions

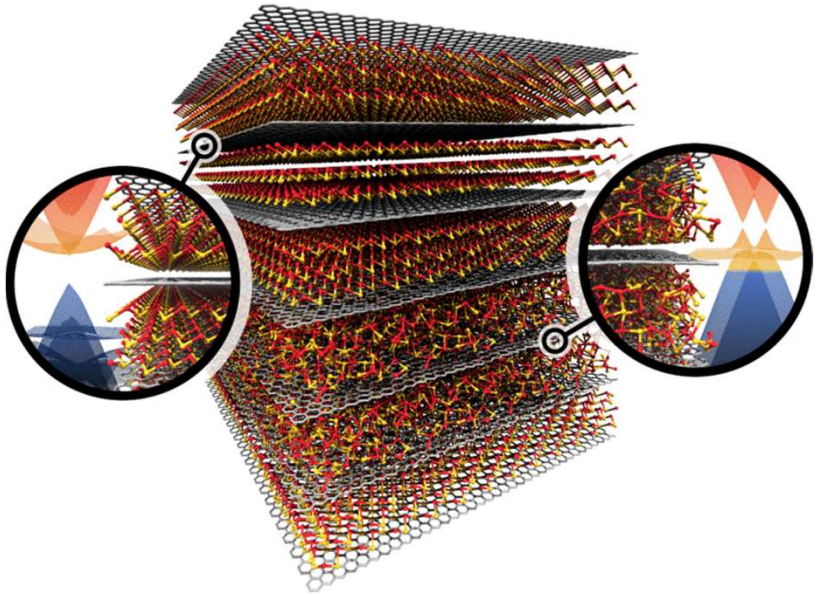
$$E_0 = E[n_0] = \left\langle \Psi[n_0] \left| \hat{T} + \hat{V} + \hat{U} \right| \Psi[n_0] \right\rangle$$

$$V_s(\vec{r}) = V(\vec{r}) + \int \frac{e^2 n_s(\vec{r}\,')}{|\vec{r} - \vec{r}\,'|} \mathrm{d}^3 r' + V_{\mathrm{XC}}[n_s(\vec{r})]$$

← DFT!

Projects offered 2022:

- Fingerprinting of atomistic defect sites in oxides via machine learning, relevance for microelectronics applications (one project)
- Machine learning of atomic migration and Kinetic MC for modelling of precipitate formation in Al (two projects)
- Catalytic reactions of CO_2 on metal clusters, production of synthetic fuels (one project)



Assoc. prof. Raffaela Cabriolu

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Main research interests:

- Molecular simulation techniques for physical-chemistry applied
- problems.
- Rare events and Nucleation processes.
- Colloidal and Glassy systems.
- Nano-porus materials.
- Scientific software development.

Project offered fall 2022:

- Understanding non-newtonian fluids.
- Mixing-Demixing and Phase transitions in colloidal systems.
- Dimensionality effect on thermal conductivity.

Prof. Ton van Helvoort

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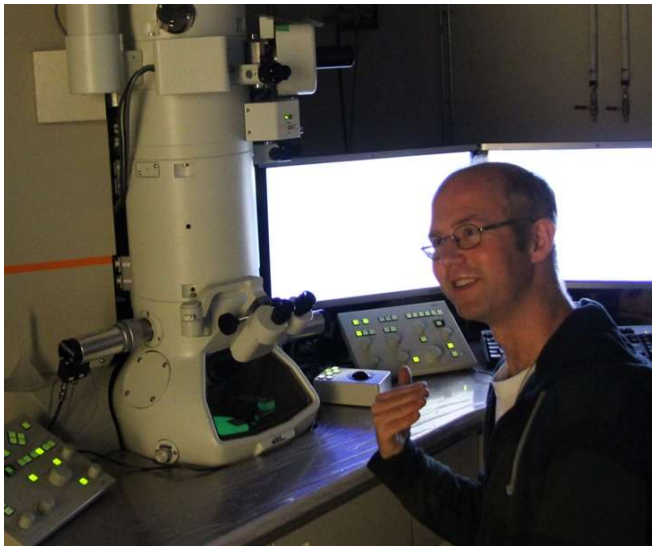
TEM Gemini Centre

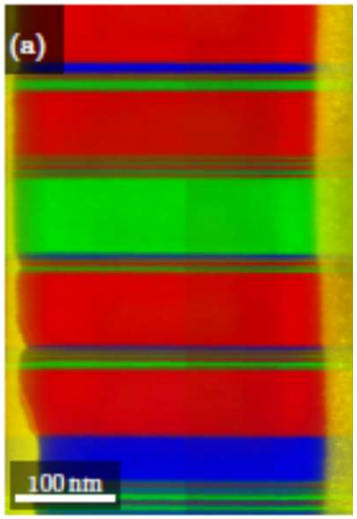


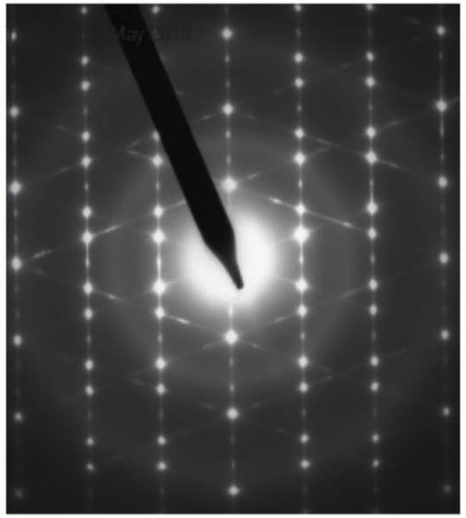
Main research interests:

Application and development TEM, STEM, and SEM.

Electron microscopy novel data analysis (incl. machine learning) in open-source.

Electron crystallography: structure-property relations.





Project offered H2022:

- Data mining electron diffraction data stacks
- Improving the accuracy electron spectroscopy
- TEM study of functional oxides and minerals

Prof. Randi Holmestad

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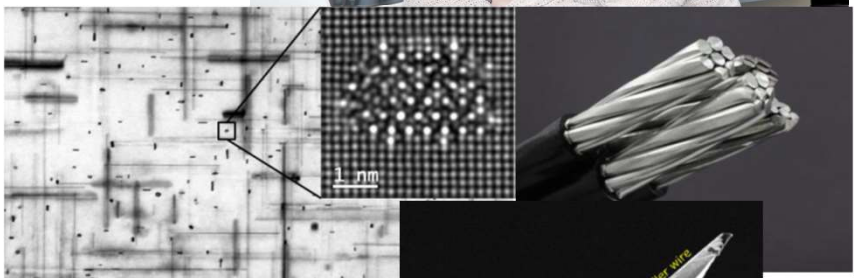
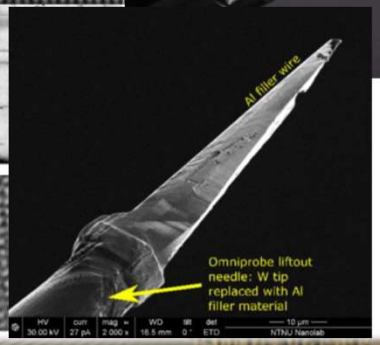
TEM Gemini Centre

Main research interests;

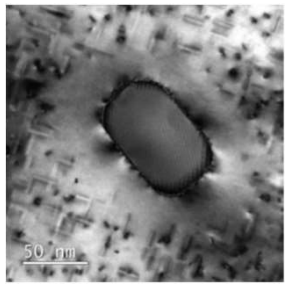
Materials physics and transmission electron diffraction and microscopy (TEM), materials microstructure and the relation to macroscopic properties.

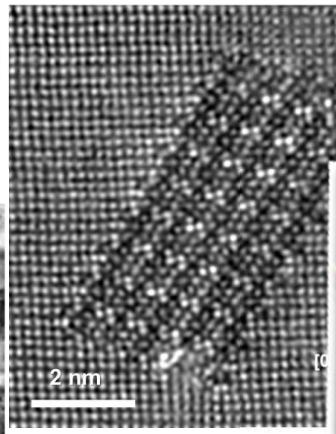




Projects offered 2022;

- Aluminium alloys (summer job or internship to Japan)
- Multi-material joining (summer job + if you want to work with FIB!)
- Conductivity at the nanoscale (with Ragnvald Mathiesen)
- Catalysis/membranes (with Tina Bergh/ Per Erik Vullum)
- Strain measurements (with SINTEF)





See all projects from the TEM group here!

https://www.ntnu.edu/physics/temgemini

Assoc. prof. Magnus Nord

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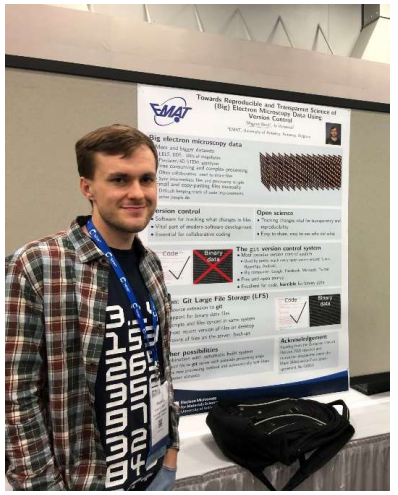
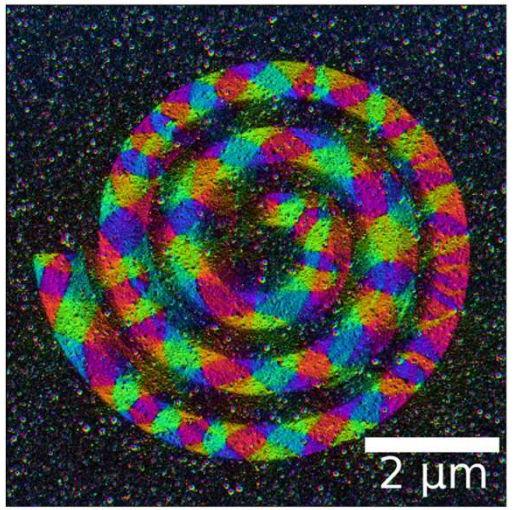


Main research interests:

- Development of TEM techniques using new high speed cameras
- Image magnetic fields in materials at nanometer length scales
- Developing "Big data" processing software using scientific Python
- Open source scientific software development

Project offered 2022:

- ~~Nanoscale structural and magnetic studies of perovskite oxide thin films using TEM~~
- ~~Nanoscale imaging of ferromagnetic artificial spin ice structures using Transmission Electron Microscopy~~
- Electron microscopy of thin films for spintronics applications



TEM image of ferromagnetic domains in a spiral shaped nanostructured thin film. The colours showing the magnitude and direction of the magnetic domains.

Prof. Morten Kildemo

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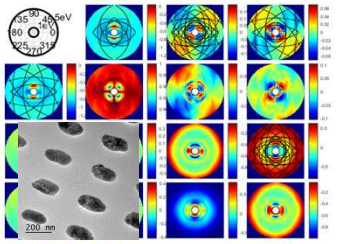
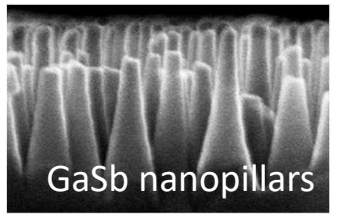
web Page for activity: https://www.ntnu.edu/physics/nanophotonics-and-polarimetry

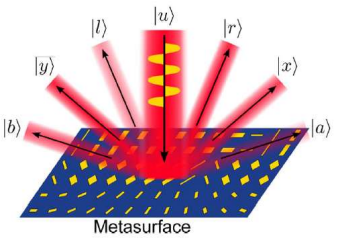
https://www.ntnu.edu/employees/morten.kildemo





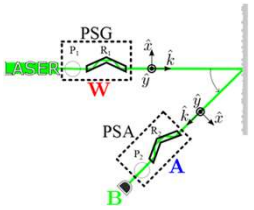
Main research interest:

Design*, nano*manufacture* and *metrology (instrumentation) of novel optical functional materials ranging from nanostructures applied to Photovoltaic absorbers/ AR coatings and nanoplasmonic devices. Recently focused on so-called **metasurface**-based light-weight lenses, polarimetric components, holographic elements, vector beams etc., based on surfaces with **well- designed dielectric and/or plasmonic nano-resonators.** A new collaborative project in the group is to develop the field of **coupling of photons to magnons**, and another new collaborative project with CERN within **plasmonics** in high gradient accelerators.



Projects 2022:

- **Manufacturing (and characterization)** of metasurface designs based on well-designed nanoresonators through structuring of a-Si and/or TiO_2 thin films/layers (Nanolab).
- **Computational Modelling and design** of nano-optics structures through FDTD, FEM, RCWA for design of optical functions using metasurfaces.
- **Instrumentational projects in optics :** Characterization and modelling of metasurfaces and nano-optics on optical bench



Prof. Turid Reenaas

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Main research interest

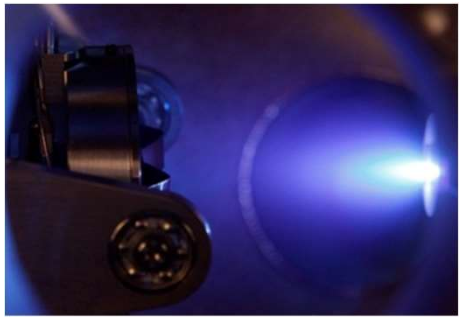
Intermediate band solar cells; theoretical efficiency approx. 49% compared to 33% for conventional solar cells

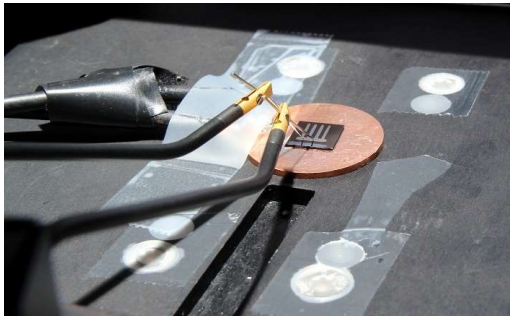
Project offered 2022

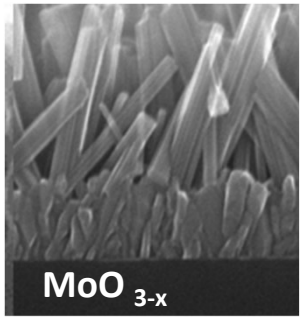
- Intermediate band solar cell simulations
- Pulsed laser deposition and characterization of doped TiO_2 and non-stochiometric TiO_{2-x}
- Processing/recrystallization of implanted (TiO_2 and Si) films and single crystals
- Device fabrication and testing

Relevant characterization techniques

- electron microscopy (SEM, TEM),
- X-ray diffraction (HR-XRD),
- optical spectroscopy,
- photoelectron spectroscopy (XPS),
- surface topography (AFM, optical profilometer)



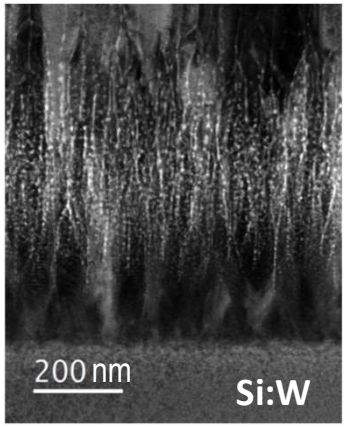


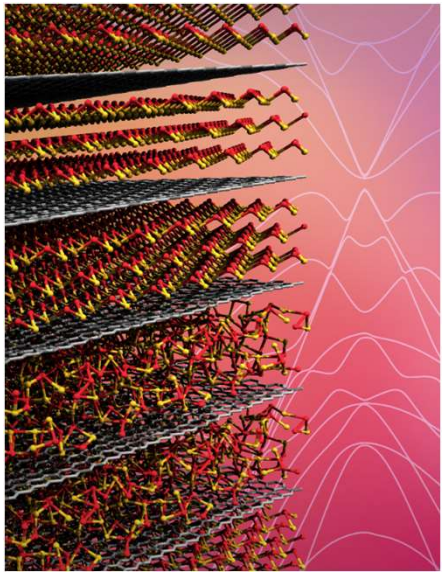


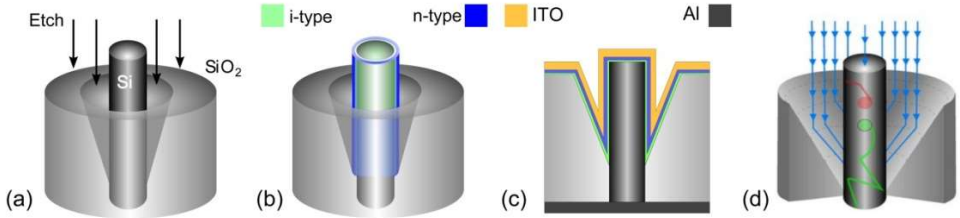
Interested in learning more?

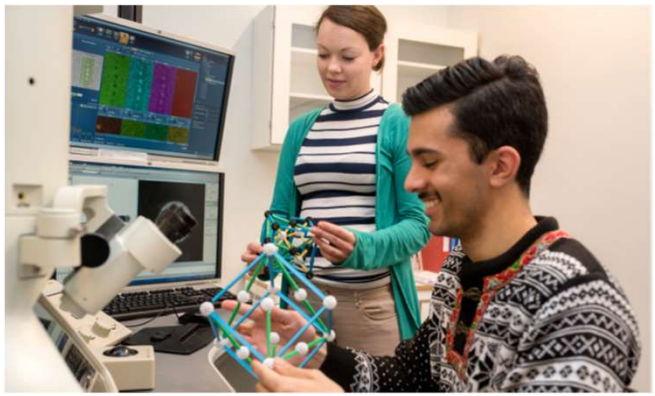
We invite you to meet us for coffee and waffles on Tuesday 5th April at 12.00 in R60 (E3-103) to get more detailed information about the projects.

..or contact us by email or phone!









$$E = E_0 + V_0 \sum_i \sigma_i + V_1 \sum_{\langle ij \rangle} \sigma_i \sigma_j + \cdots$$