Project/Master topics
at
Department of Structural Engineering
(2023-2024)

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The Faculty





Characteristics of the group

- Interdisciplinary
- International
- Industry relevance
- Weekly webinars
- **Modelling & Lab**
- **Local properties**
- **Macroscopic performance**

Typical project studies in our group

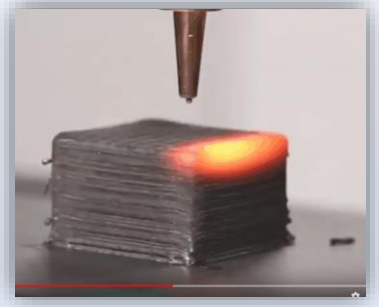
- **7.5 study points**
- **A guided literature study** to learn about the topic (1/3-1/2)
- Guided preliminary **modelling** or **lab work** (1/3)
- **Summarize the understanding**, analyze and formulate the preliminary results (1/3)
- **Plan for the master study**
- **Weekly supervising meetings**
- **Interaction with PhD students and post docs**

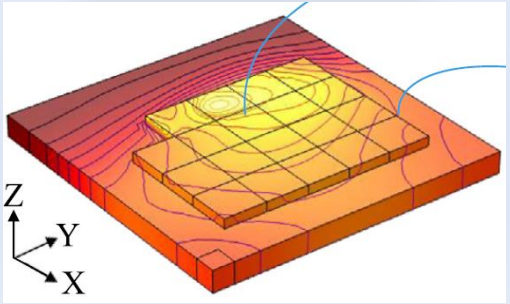
Today's technological trends

- **Digitalization**: modelling, machine learning, digital twinning
- **Sustainability**: efficiency, life extension
- **Hydrogen energy**: hydrogen transport and storage

Project Topic: Modelling of 3D printing

- **3D printing** in principal works for any material, any shape, any quantity and in any fields, without the need for specialized tooling.
- **Challenges:** No control of printed properties
- **Needs:**
  - Modelling of thermal fields
  - Modelling of mechanical properties
- **1-2 students**
- Working with **PhDs and SINTEF**

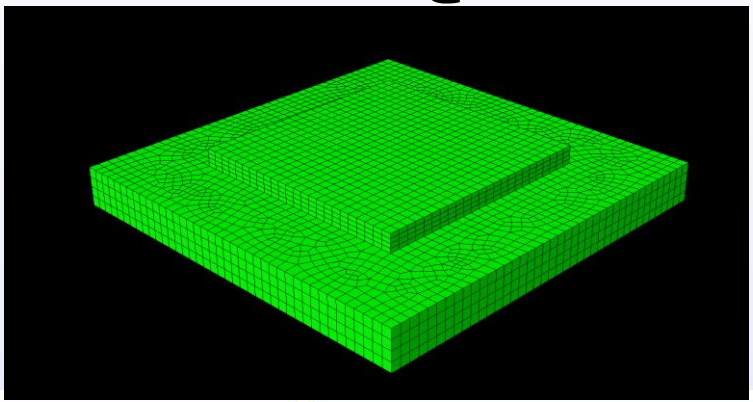


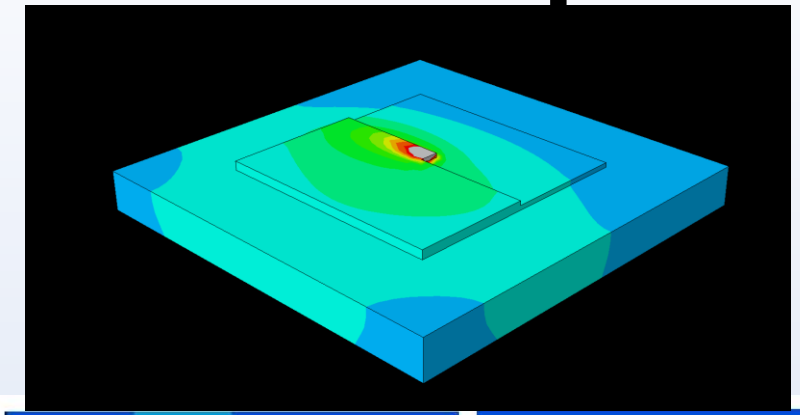


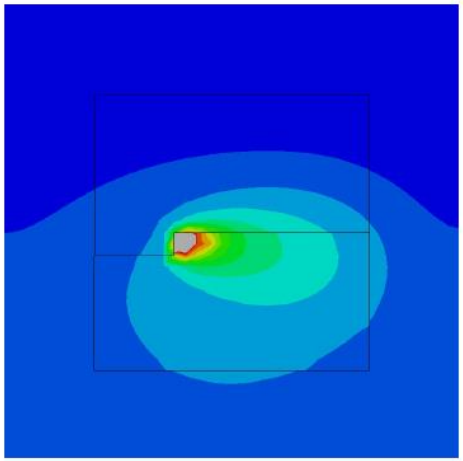
Topic 1: Modelling of 3D printing

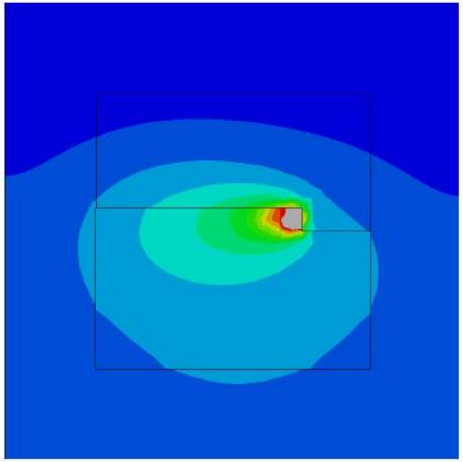
- **ABAQUS**
- **Machine learning**

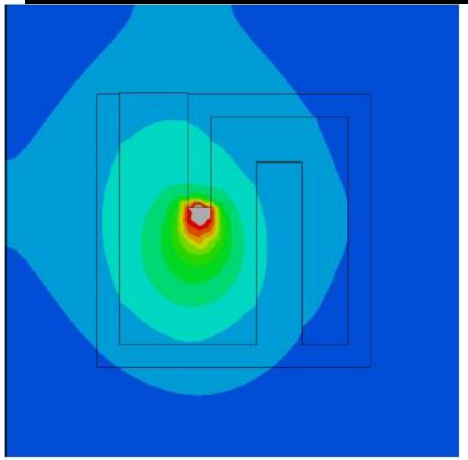
Typical ABAQUS models for 3D printing

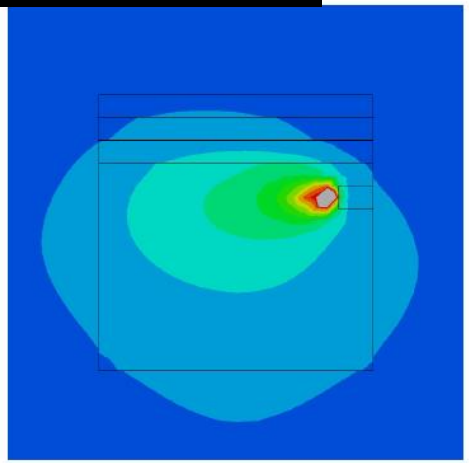






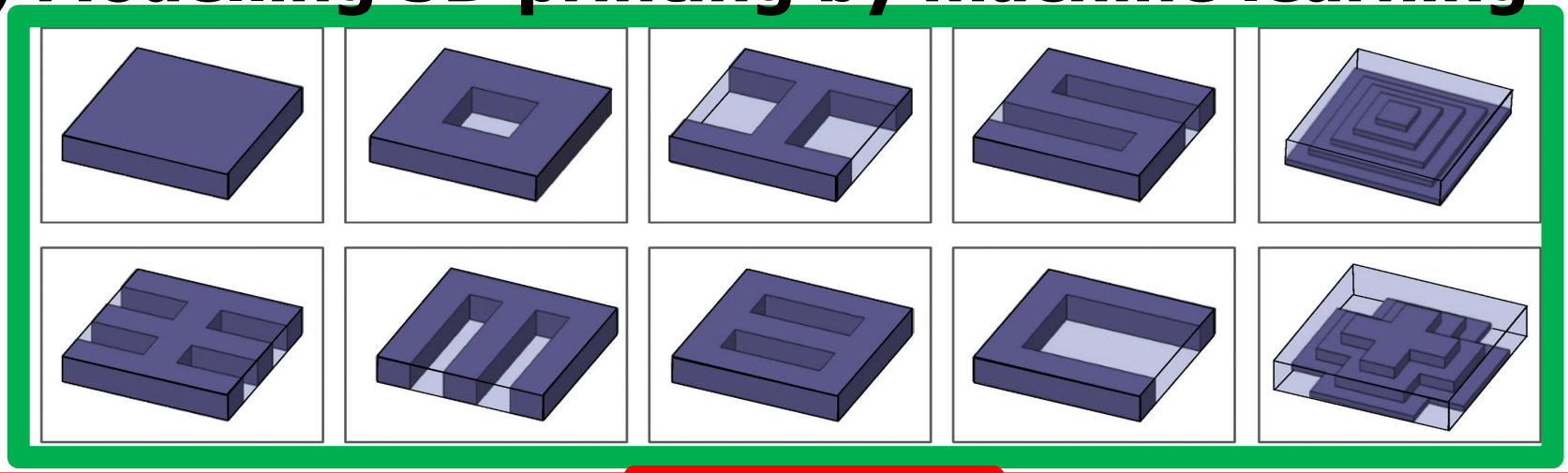


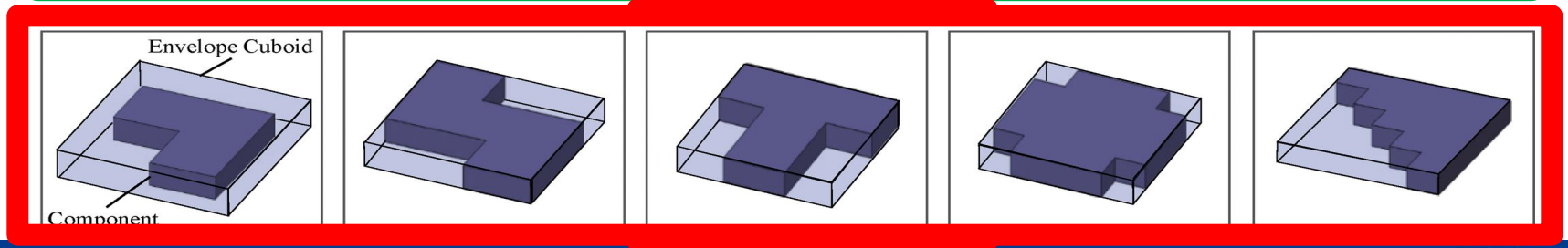




Master topic alternatives:

1) Continue modelling 3D printing with Abaqus
2) Modelling 3D printing by machine learning





Early master student's work example

Journal of Materials Processing Technology

Volume 302, April 2022, 117472

Towards a generic physics-based machine learning model for geometry invariant thermal history prediction in additive manufacturing

Kari Lovise Ness [a], Arindam Paul [b], Li Sun [a], Zhiliang Zhang [a]

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Topic 2: Safety of hydrogen infrastructure

Topic: Safety of hydrogen infrastructure

Hydrogen, fuel of the future!

Safe Pipelines for Hydrogen Transport – a large scale project financed by the Research Council of Norway and many industrial partners

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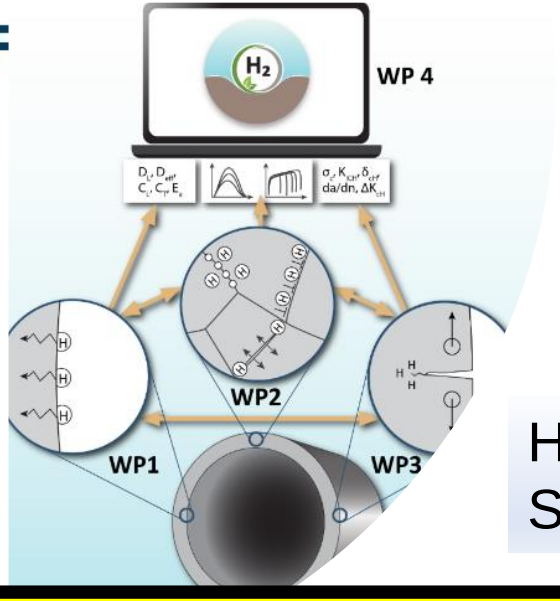
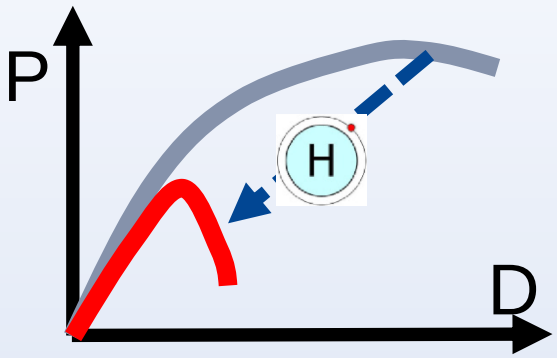


NTNU

Hydrogen energy
Safe transport

Research question: Is it safe to use the existing gas pipelines to transport H2 from Norway to market?

Safety of Hydrogen infrastructures

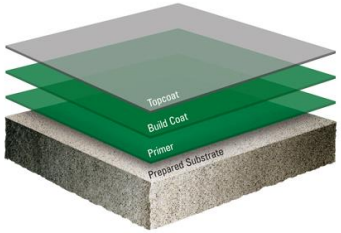


- Use ABAQUS to model the material and structural behvaiours when exposed to hydrogen
- Model **how the material degrades** and its consequence to the safety
- **Leading competence in this field**
- **Working in a large team**
- Gain valuable experience in coming hydrogen technology

Topic 3: Tailoring adhesion

- ABAQUS
- Indentation experiment
- Dynamic mechanical analysis

Tailoring adhesion in paint



- Adhesion of polymer to polymer
- Adhesion of polymer to metal
- Optimization of adhesion

Outcome

- Reducing risk of coatings failure
- Increasing reliability of the coatings
- Increasing sustainability and lowering the foot-prints via longer-lasting coatings
- Tailor-made coatings aligned with customer needs
- Reduction of cost for customers and time of maintenance

Project work

- Finite element analysis of paint adhesion
  - Abaqus
  - 2-3 students
- Experimental characterization
  - Indentation based interface adhesion characterization
  - Dynamic mechanical analysis of structure-property relationship
  - 2 students
- Working team
  - PhD and postdoc research at NML
  - Researchers at Jotun AS and SINTEF industry

Topic 4: Molecular mechanics

- Molecular dynamic simulation
- Machine learning

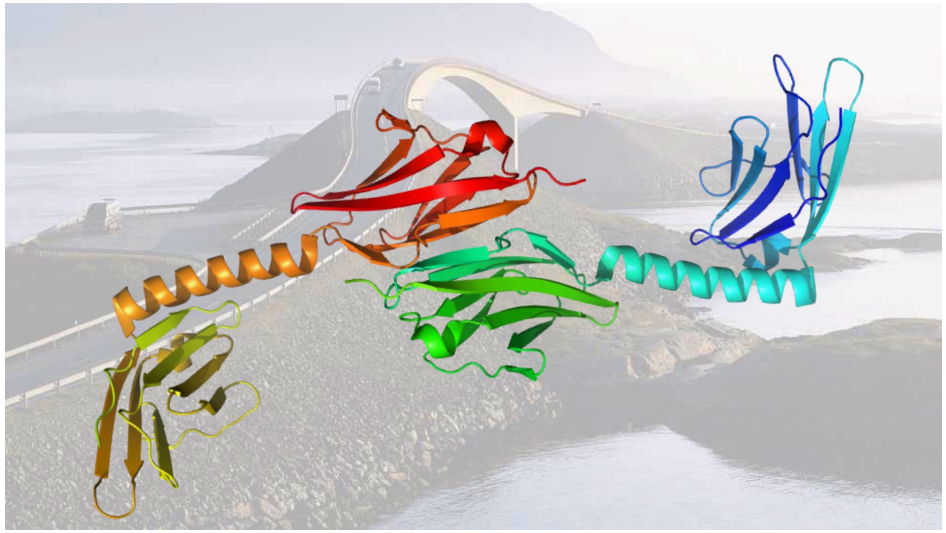
We study bridges and buildings

Atlanterhavsveien

Tyholt Tower

We study bridges and buildings

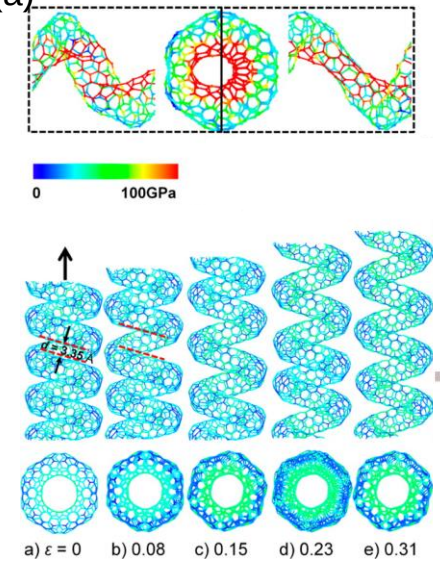
at the Nanoscale too



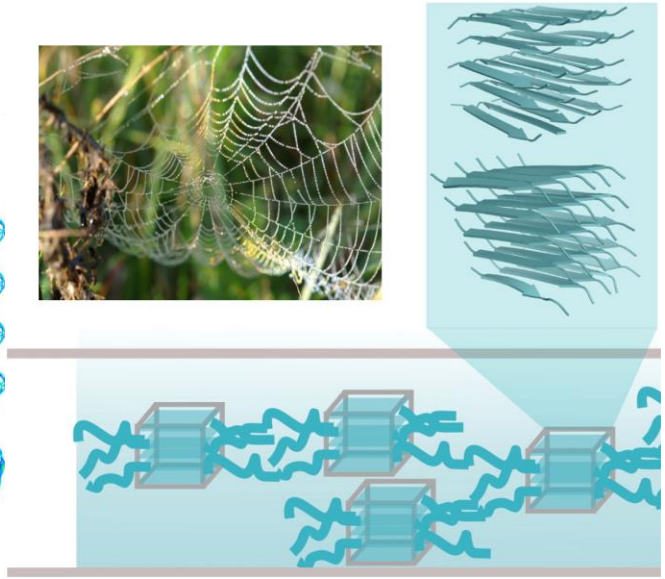
Molecules for withstanding forces

Molecular mechanics: mechanical stability of molecular structures

(a)



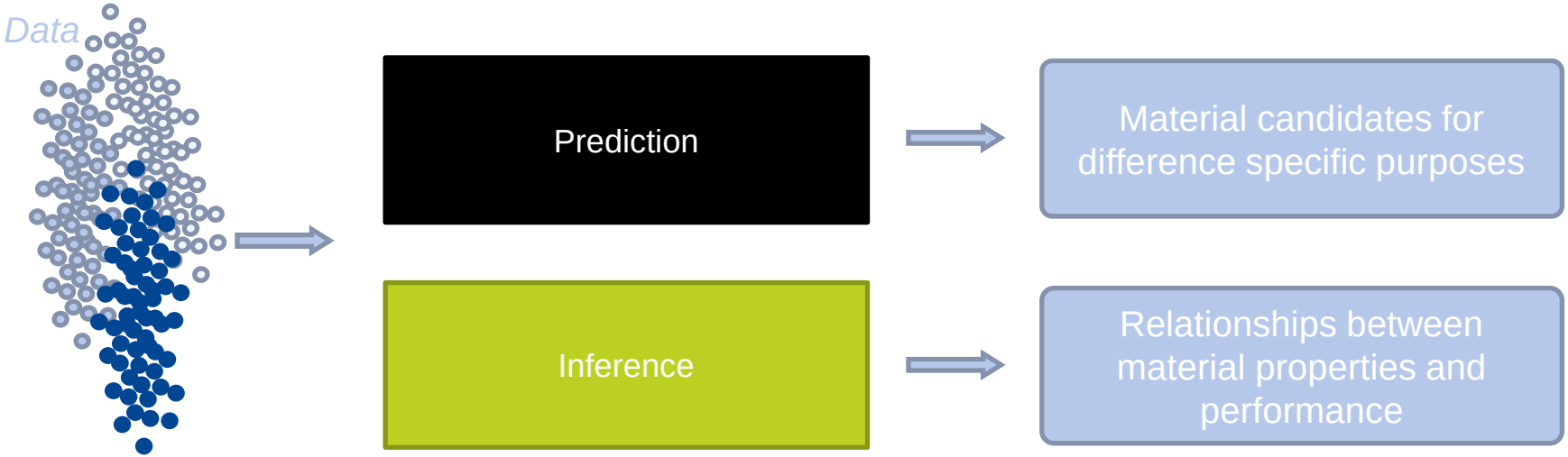
(b)



(c)

Machine learning materials science

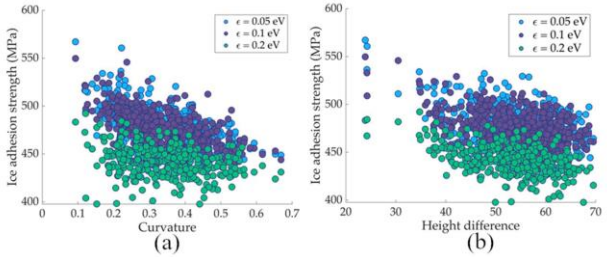
black and “not-so-black” boxes

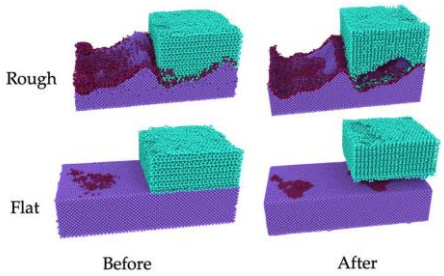


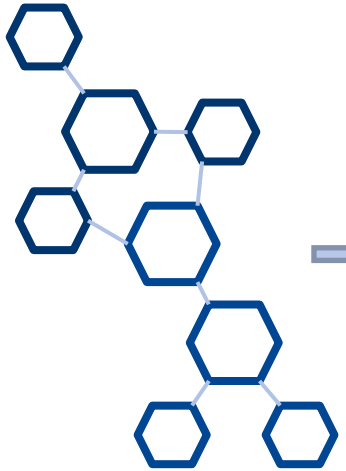
Machine learning materials science

Example: machine learning nanoscale ice adhesion

Data



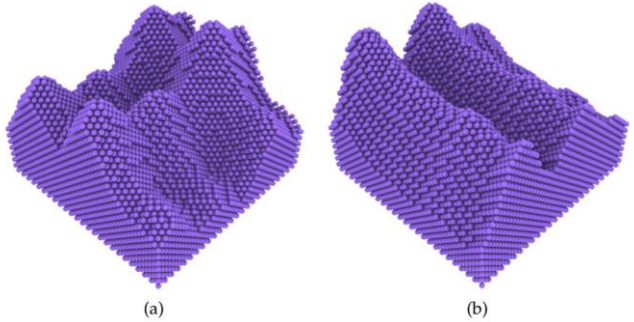




Machine learning algorithms
(Matlab, Python, R, Octave)

Predictions

Surface topologies with
highest (a) and lowest (b) ice adhesion



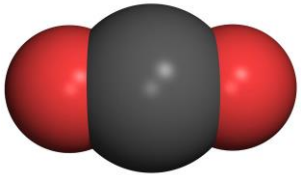
Master Thesis topics:

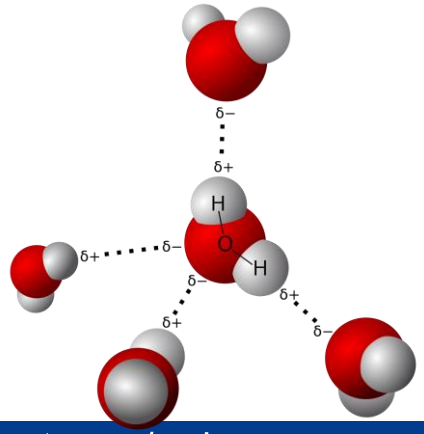
CO_2, H_2O and H_2

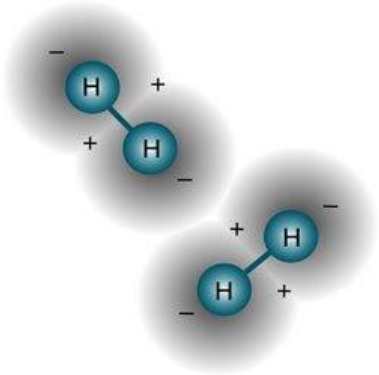
Dynamics and their interactions with other materials

Atomistic modeling and literature review in related research fields:

- *Carbon capture and storage*
- *Ice, hydrate, and water research*
- *Hydrogen energy*



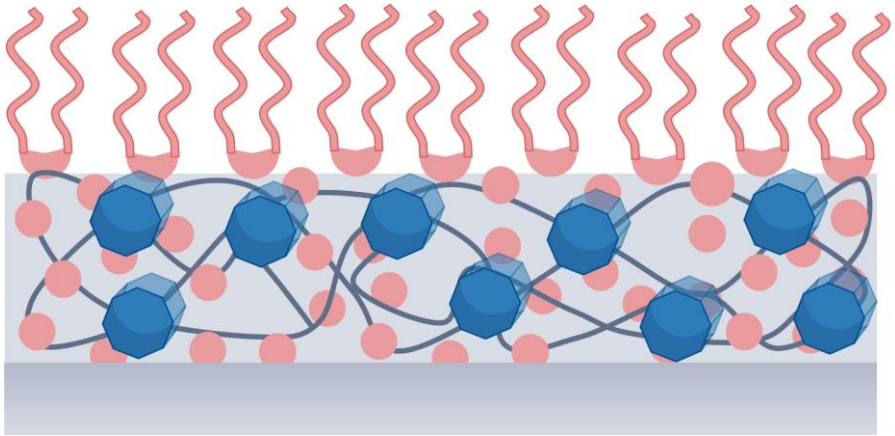




Atomistic modeling of coating polymer adhesion and interactions

Atomistic modeling and literature review in related research fields:

- *Under water adhesion*
- *Biofouling on marine infrastructure*
- *Polymer, surfactants and microemulsions*



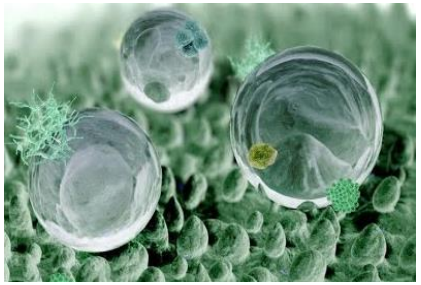
In cooperation with industry

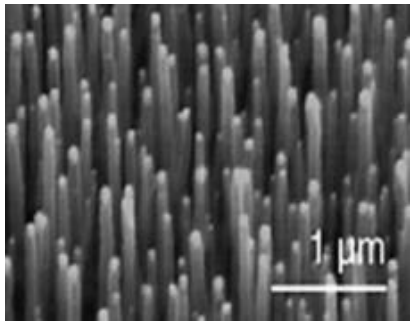
Topic 5: Nature-inspired water and ice-repelling nanostructured surfaces

- Literature review
- Data collection and analysis

Smart surfaces

- Classification of the nanostructured natural surfaces discovered in plants and animals and studied in literature.
- Discussion of the physical and chemical mechanisms of the “smartness”.
- Elaboration of simplifies models of the nanostructured natural surfaces and computations of their surface energy.
- Comparative analysis of their smart properties and propositions for experimental verification of theoretical results and discussion of possible application.





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