Materiale- og overfladeteknologi

Materials and Surface Engineering

Student projects Spring 2013

The section for Materials and Surface Engineering has expertise in many aspects of materials science and engineering and covers disciplines as materials synthesis, materials solutions, materials characterisation, materials performance and materials modelling. The section consists of 8 faculty staff and teaches and researches in topics covering fundamental materials science as well as innovative materials engineering solutions. Within the section three broad titles cover the many activities.

Surface engineering and materials design

Surface engineering is the major materials synthesis activity in the section and for this purpose electrochemical, thermochemical and PVD techniques are applied and further developed. The research activities in surface engineering cover the entire chain from basic research of generic importance to applied research, engineering and innovation.

Microstructure evolution and phase transformations

Materials microstructure evolution during processing as well as during application lies at the very essence of understanding the relations between process parameters, properties and performance. Understanding the occurring microstructure evolution and phase transformations in materials form the basis for materials modelling activities.

Materials performance and degradation

Research in materials performance and materials degradation is concentrated on corrosion, tribology and high temperature performance (creep and corrosion), i.e. the chemical, biological, mechanical and thermal interaction (or combinations thereof) of materials with the environment. The strategy is to investigate, identify and understand the degradation mechanisms that affect the performance of materials and to use this understanding to predict the life expectancy and design of improved materials solutions.

Currently, we focus on materials for (sustainable) energy applications and materials in medical applications. We have a broad international network of collaboration within academia and industry.

Faculty staff:

Marcel A.J. Somers- head of section
Per Møller
Rajan Ambat
Andy Horsewell
Seunghwan Lee
Karen Pantleon
Wolfgang Pantleon
Grethe Winther

Aqueous Lubrication of Engineering Materials with Brush-forming Polymers

Injectable Lubricants to Improve Longevity and Biocampatibility of Orthopaedic Implants

Characterization of Non-Woven Biodegrable Implants

Steamside Oxidation during High Temperature Exposure of Superheater Tubes in Thermal Power Plants

Optimization of Dual Phase Model Alloy

Improved Materials for Fusion Reactors

Monitoring Fatigue in fcc Metals with X-rays

Analysis and Modelling of Grain Rotations during Deformation of Steel

Climatic Reliability of Electronic Devices

Surface Modification of Aluminium Alloys

Development of Porosity in Nitrides

Coatings for High Temperature Protection in Biomass-Fired Power Plants

Surface Engineering of Metallic Implant Materials

Surface Engineering of Bearings in Wind Turbine Drivetrains

Development of Anodic Electrodes for Alkaline Electrolyzers

Development of Cathodic Electrodes for Alkaline Alectrolyzers

Materialekarakterisering af Solcremer

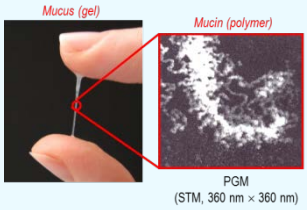
Aqueous Lubrication of Engineering Materials with Brush-forming Polymers: From Mucins to Biomimetic Polymers

Supervisor: Seunghwan Lee (seele@mek.dtu.dk, Tel: 4525 2193)

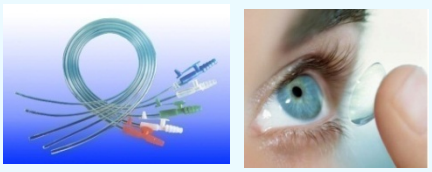
The lubrication of two surfaces in relative motion is aimed at the reduction of the interfacial friction, and this often reduces wear, pain or costs – depending on the tribosystem. In most engineering systems, lubrication is achieved with oil-based lubricants. However, these conventional engineering lubricants are undesirable in several fields, namely in biomedical engineering, food, textile or mining industry. Additionally, environmental issues and resource limitation associated with oil-based lubricants ask for alternatives. A most attractive candidate, which is already successfully employed as lubricant in Nature, is water. For example, mammalian synovial joints are lubricated with a water-based fluid and the resulting friction coefficients of 0.001 are ideally maintained for a lifetime. Unfortunately though, water has extremely low pressure-coefficient of viscosity, in other words, water cannot increase its viscosity under pressure effectively and is thus easily squeezed out of the contact zone. Nature overcomes this dilemma by employing water-soluble, surface-adsorbing macromolecules that often reveal brush-like structure, such as mucins, lubricin and other glycoproteins, to entrain and keep the lubricant, water, at the gliding interfaces.

Oil and water as lubricant

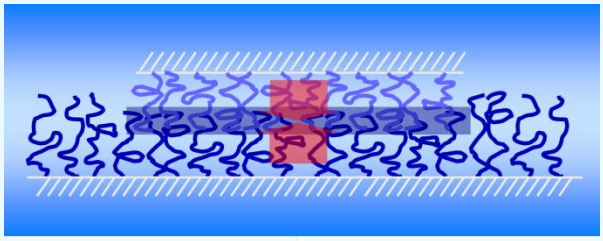
Mucin and mucus gels



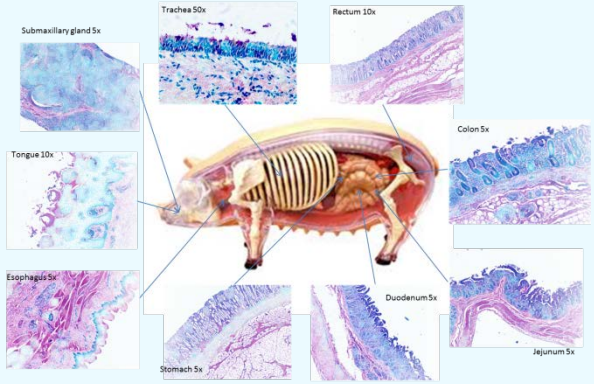
Water lubrication in biomedical area



Conformation of brush-forming polymers



Mucus gels on the surfaces of internal organs



Aim of the projects

With an ultimate goal to design water-compatible, eco-friendly, and biomimetic tribosystems, the specific aim of these projects are to investigate the aqueous lubricating properties of several water-soluble biopolymers and synthetic polymers at tribological contacts. Silicone-based elastomers are to be employed as the tribopair to mimic soft biological tissues and to provide compliant contacts, whereas thermoplastics, ceramics, and metal-metal alloys are to be employed as the tribopairs to represent engineering tribosystems. Additionally, the influence of many operational parameters, such as temperature and electrolytes of the aqueous solution, will also be investigated to further characterize these tribosystems. Multiple master projects are currently available.

Materials and Surface Engineering
Department of Mechanical Engineering

Injectable Lubricants to Improve Longevity and Biocompatibility of Orthopaedic Implants

Supervisor: Seunghwan Lee (seele@mek.dtu.dk, Tel: 4525 2193)

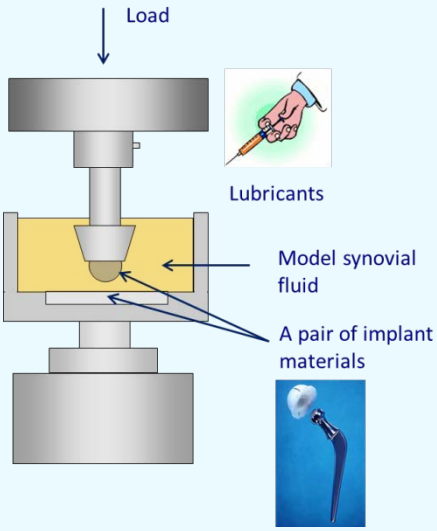
Kirsi I. Pakkanen (kipa@mek.dtu.dk, Tel: 4525 2223)

Wear of orthopaedic implants has long been recognized as the principal cause of degradation and failure of the implants. The particulate wear debris generated from articulation between two moving parts of the prosthetic joints can initiate a cascade of adverse tissue responses, leading to osteolysis and aseptic loosening of the components. Thus, improvement of tribological properties of implant materials is directly improving the biocompatibility and longevity for prosthetic joints. To date, efforts to solve this problem have been directed towards the development/application of new materials with superior tribological properties.

The present study is based upon a markedly different viewpoint into the problem; instead of developing and/or applying new materials for implants to resist wear, we aim to reduce the wear of implants by administering lubricants to prosthetic joints. This is primarily based upon recent development of polymeric lubricant additives that are water-soluble and improve anti-friction and anti-wear properties of a variety of engineering materials, including metal alloys, polymers, and ceramics, which happen to be the same types of materials for orthopaedic implants. A most outstanding merit and novelty of this approach is that currently prevailing orthopaedic implant materials, which have been proven to be excellent in many aspects as implant materials, except for their inadequate tribological properties, can benefit without any further modification.

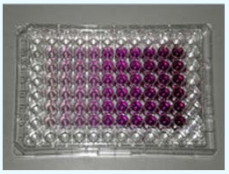
Furthermore, since the external lubricants are independently administered from the implant manufacturing and surgical processes, not only those patients who will be receiving articular joint prosthesis surgeries in the future, but also those who have already received them in the past can benefit from this approach.

Research activities in the projects

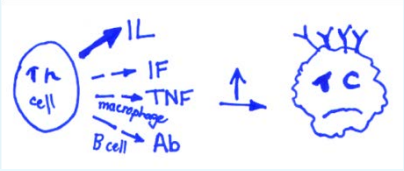


The research activities in this project are composed of (i) screening external lubricants and investigate the lubrication mechanisms employing model implant materials and model synovial fluids, (ii) biocompatibility tests composed of cytotoxicity (MTT assay) towards external lubricants and immune cell responses towards wear particle with or without lubricants. Depending on the interests, a part of the research activities can be chosen.

Cytotoxicity



Immune responses



Materials and Surface Engineering
Department of Mechanical Engineering

Characterisation of Non-woven Biodegradable Polymer Implants

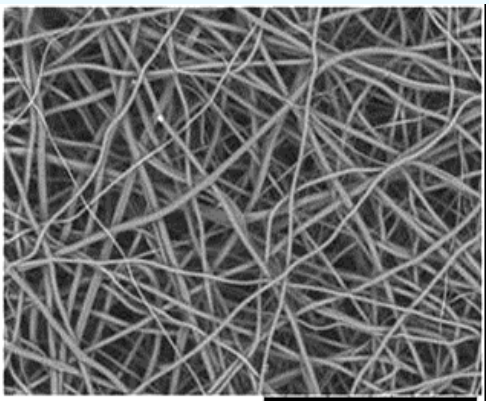
Supervisor: Andy Horsewell, (anho@mek.dtu.dk),
Monica Gallego, Coloplast Humlebæk

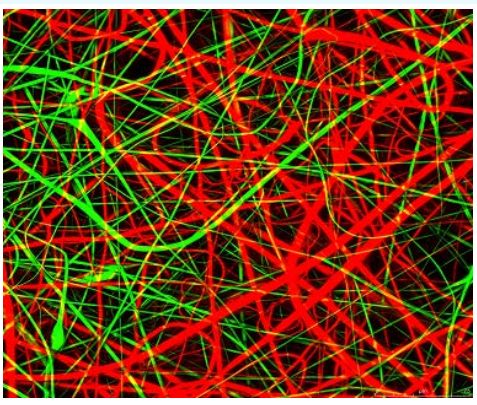
Pelvic Organ Prolapse (POP) is a condition affecting millions of women worldwide. Briefly described, POP can be understood as a hernia of the uterus or bladder. Few surgical procedures are available to treat the condition, among those a knitted polypropylene mesh can be implanted, in order to provide support to the pelvic organs. Given the advances in fields associated with tissue engineering, Coloplast research and development is very interested in developing an alternative clinical treatment based in regenerative therapy.

Non-woven implants that can function as tissue scaffolds are already being made at Coloplast by electro-spinning synthetic biodegradable polymers. As part of the characterization and process support for the production of these implants, methods are needed that can easily extract information from images taken by SEM and/or confocal microscopy. Please see example of images below.

Projects within this area will include (BSc and MSc projects);
a) the development of an image processing technique that will allow automated determination of fibre size distribution, directionality and pore size in these implants;
b) development of electron microscopy techniques that can be used to follow degradation of the polymer fibre microstructures
c) analysis and control of the degradation mechanisms in this class of biodegradable polymer.

The projects will be carried out in close collaboration with Coloplast, including participation in the research group at Coloplast, Humlebæk





Materials and Surface Engineering
Department of Mechanical Engineering

Steamside oxidation during high temperature exposure of superheater tubes in thermal power plants

Supervisor: Karen Pantleon (kapa@mek.dtu.dk),

Melanie Montgomery, Vattenfall / Heat Nordic

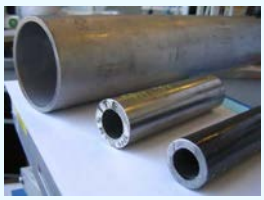
Steamside oxidation of steel tubes applied in power plants can cause serious problems, because oxide spallation can result in blockage of the loops and cause insufficient steam flow through the superheater and, consequently, overheating and failure of the tube.
Various steels, which have been long-term exposed in Danish power plants are available for microstructure analysis and the investigation of phase transformations near the surface.
For understand the mechanisms of occurring surface modifications, systematic studies of corrosion under well-controlled laboratory conditions are required as a function of temperature 500 ... 700°C for different gas environments.

Several issues can be addressed in **various student's projects** on high temperature corrosion (specific content and corresponding time frame can be adapted as needed). For example, the following topics could become relevant BSc or MSc projects or inspire for smaller projects:

1. **The influence of chemical** (e.g. pre-oxidation) **and/or mechanical surface treatment** (e.g. shot peening) **on high temperature corrosion of superheater tubes in various atmospheres** (e.g. CO_2, C_2H_2, CO, chlorine containing gases as relevant for biomass firing).

2. **The influence of the sample's geometry** (concave versus convex parts of the tube, in comparison to flat samples) **on the evolution of stresses during high-temperature corrosion on the steamside of superheater tubes.**

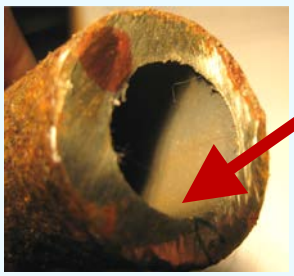
All projects will need to include both thorough literature studies and experimental work, like sample pre-treatement, high-temperature corrosion experiments and materials characterization.



before …

… after

high temperature corrosion in power plants…



steamside
= inner side of the tube

Optimization of a dual phase model alloy

Supervisor: Karen Pantleon (kapa@mek.dtu.dk)

The development of advanced methods for materials characterization often requires well defined, simplified materials both for testing purposes and fundamental materials investigations.
For example, for understanding the elastic and plastic deformation behaviour of multiphase materials on the sub-micron scale, a copper-iron alloy is considered a suitable model system.

As copper and iron are practically immiscible at room temperature, the resulting microstructure of the iron-copper alloy will consist of well-separated regions of copper and iron. These two single phases with their specific crystal structure (FCC copper and BCC iron) represent an interesting combination of essentially different mechanical properties within the multiphase material.

The project aims at

- the **synthesis of such a model alloy** consisting of 50wt% Cu and 50wt% Fe and
- the **optimization of the internal structure** of the alloy with special focus on a homogeneous distribution of the two phases and uniform grain sizes in the range of only a few up to several tenths of micrometers.

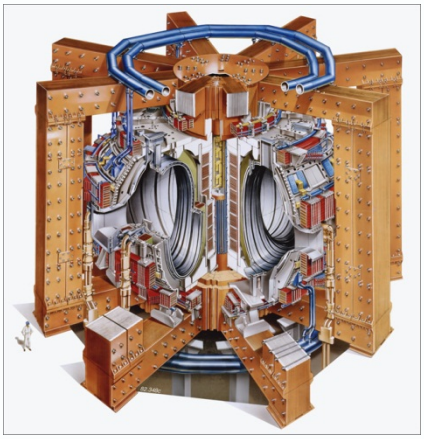
The practical work involves, in addition to appropriate heat treatment procedures, thorough analysis of the microstructure applying various microscopic techniques (light and electron microscopy) and X-ray diffraction for the phase-specific determination of preferred crystallographic orientations of grains and internal lattice strain.

The project is meant to be a MSc project, but parts of it can be formulated as a BSc project, if needed.

Improved materials for Fusion Reactors

Supervisor: Wolfgang Pantleon (pawo@dtu.dk)

One of the key issues in building fusion reactors is the selection and development of materials being able to withstand high temperatures as well as high mechanical and radiation load which alter the microstructures of the materials during service. The suggested projects will focus on the microstructural property relationships of two different types of materials relevant for fusion reactors:



- **Low activation ODS ferritic steels** have been developed for construction parts in fusion reactors with the purpose of remaining strong at high temperatures. For improving their properties, grain refinement to the nanoscale is proposed. The aim of the project is to characterize the microstructure of the base material - a ferritic martensitic chromium steel - after different mechanical processing and to evaluate the achievable improvement in performance under thermo-mechanical loading.

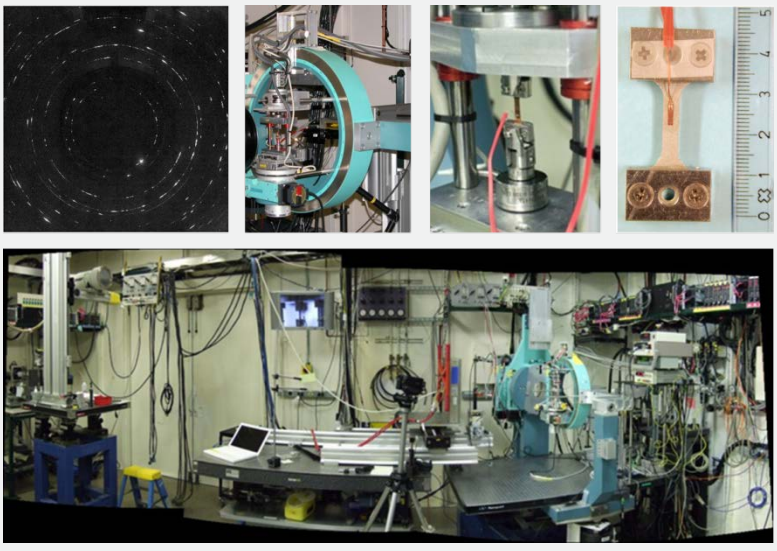
- **Tungsten** is considered as preferred candidate for the plasma facing first wall material of fusion reactors. In service, the materials have to withstand high temperature (and radiation loads) altering their microstructure. The replacement of the instable microstructure leads to degradation of the mechanical properties as a loss in strength. The aim of the project is to investigate the thermal stability of differently processed tungsten with focus on the mechanisms relevant for property degradation.

Monitoring fatigue in fcc metals by x-rays

Supervisor: Wolfgang Pantleon (pawo@dtu.dk)

During plastic deformation of metals, the defects carrying plastic deformation are stored in dislocation walls separating dislocation-free subgrains. These emerging structures require applying higher and higher loads for continuing deformation (work-hardening) and, eventually, cause failure. A peculiar type of deformation occurs during **fatigue** when the sense of the deformation is reversed repeatedly. Even small plastic strains applied repeatedly e.g. in tension compression cycles cause formation of ordered dislocation structures which after a large number of cycles eventually lead to failure.

The evolution of dislocation structures during cyclic deformation can be monitored *in-situ* by X-ray diffraction. **High-energy x-rays** available at synchrotron sources provide bulk penetration and the opportunity of *in-situ* monitoring microstructural evolution under realistic conditions. Individual subgrains can be identified in **high resolution reciprocal space maps** from their characteristic high-intensity peaks and followed during repeated cycles.



Aim of the project is to analyze and quantify the microstructural changes occurring during fatigue of fcc metals. Preliminary data on copper have been taken already during 80.000 loading unloading cycles. Revealing the microstructure evolution by tracing individual subgrains during cyclic loading from the maps will shed light on their formation mechanism and further the insight in the initiation of failure.

Materials and Surface Engineering
Department of Mechanical Engineering

Analysis and modelling of grain rotations during deformation of steel

Supervisor: Grethe Winther (grwi@mek.dtu.dk)

Background:

During plastic deformation of metals, e.g. forming operations, the crystal lattice of each grain in the metal rotates, which affects, for examplSupervisor: Grethe Winther (grwi@mek.dtu.dk) e, the formability and magnetic properties. Modelling the rotations is an active research field with many fundamental questions yet unanswered. For example, all models rely on assumptions on whether a grain is an independent entity or controlled by its interaction with the surrounding grains. The assumptions made have consequences for the final modelling result as well as the complexity of the modelling approach. The question is still unanswered due to the lack of experiments probing the rotations of individual grains.

The project:

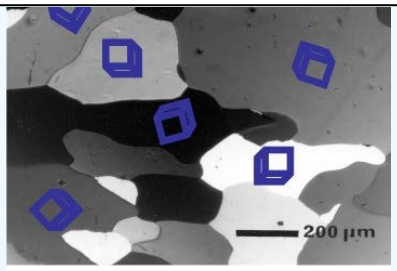
By means of synchrotron radiation, the rotations of 1000 grains in a steel sample have been measured for the first time. The project involves analysis of the rotations and comparison with models. Custom-designed software and algorithms from a previous less advanced experiment are available and the project can be extended along various lines to match the interests of the student and the type of project (diploma, BSc, MSc), eventually aiming at a paper in a scientific journal.

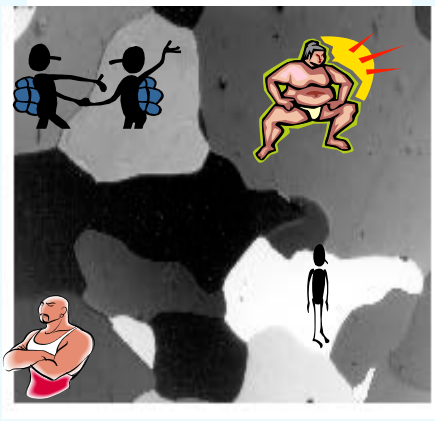
Question:

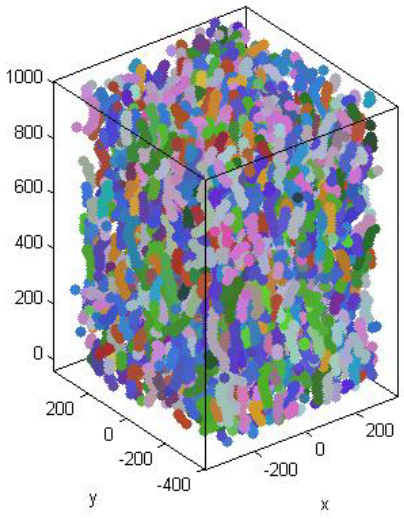
Does the orientation of the cubic crystal lattice

or

interaction between neighbouring grains control grain rotations during forming?







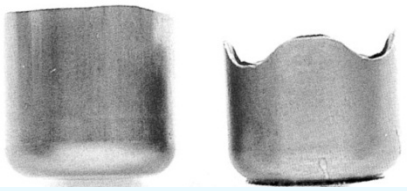
The project:

3D maps of 1000 grains rotating during deformation have been measured. The rotations are to be analysed and compared with model predictions.

Importance and relevance:

Modelling of grain rotations is important to predict the behaviour of a metal sheet in forming operations.

Which end-shape?



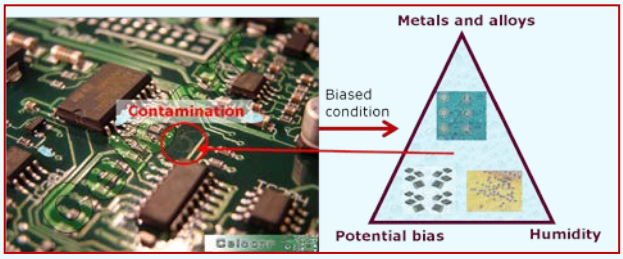
Materials and Surface Engineering
Department of Mechanical Engineering

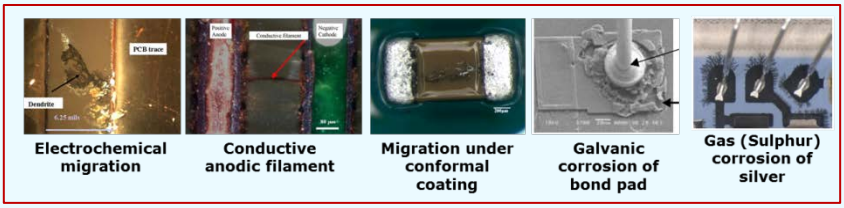
Climatic reliability of electronic devices

Supervisors: Rajan Ambat and Morten S Jellesen

Description

Climatic reliability of electronic devices has become an important issue due to the use of multimaterial combinations, potential bias, miniaturized devices, production practices, and wide spread use. At DTU-MEK, the ”Centre for electronic corrosion (CELCORR, www.celcorr.com)” investigates various aspects of electronic reliability issues in collaboration with Vestas Windsystems A/S, Danfoss A/S, Grundfos A/S, Sony Ericsson, Bosch, Bombardier, Ericsson and many other electronic industries.





Schematic showing factors causing electronic corrosion and failure modes

A number of Master/Bachelor project themes are available in this area in collaboration with the industries mentioned above. Presently many master students are carrying out their proejct investigating various issues of climatic realibility in collaboration with above mentioned industries. Broadly the subject for the projects belongs to:

- Climatic reliability issues of electronics in harsh environments
- Semi-emperical modelling of humidity inside electronic enclosures
- Climatic reliability issues of automotive electronics
- Corrosion prevention of electronic devices using conformal coatings
- Climatic Reliability modelling of circuit board design for early prediction

Exact nature of the project and theme will be formulated in discussion with the students who are interested. Interested candidates, please contact:

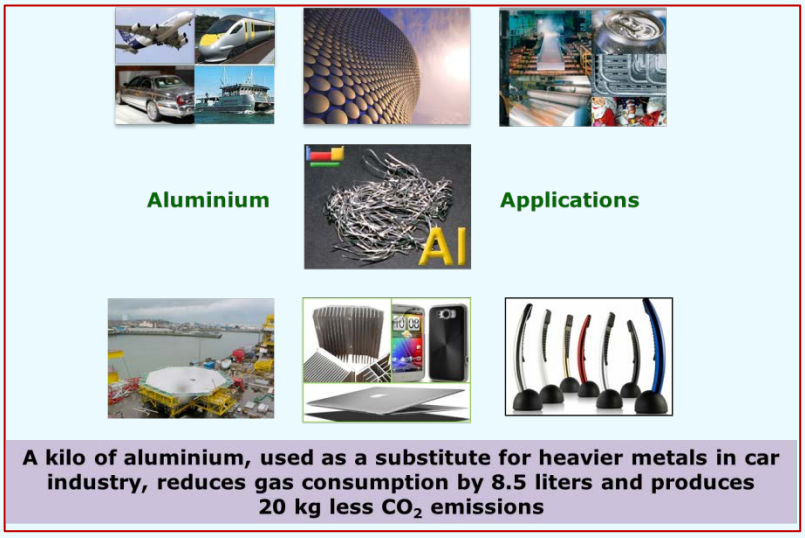
Rajan Ambat, ram@mek.dtu.dk
Morten S Jellesen, msj@mek.dtu.dk

Surface modification of aluminium alloys

Rajan Ambat, Svava Davidsdottir, Rameez Ud Din, Chakravarthy

Description

Demand for light weight aluminium alloys are increasing due to the possibility of translating light weight into higher efficiency, fuel saving in transportation, and for envrionmental protection. However, efficient use of aluminium alloys for various applications requires high performance surfaces with various functionalities. These include ability to withstand corrosive environmental conditions, optical quality surfaces, wear resistant surfaces, anti-bacterial surfaces to name a few. Materials and Surface Engineering Division works on a number projects in this areas in collaboration with industries such as Sapa, Terma, Bang and Olufsen, Seimens, PAJ systemteknik, research institutions namely DTI, TU Delft, VUB Brussels, VITO Belgium and many other partners. The aim of the work is to produce aluminium surfaces with more functionalities, which could replace a number heavy structural materails used in various technological applications.



A kilo of aluminium, used as a substitute for heavier metals in car industry, reduces gas consumption by 8.5 liters and produces 20 kg less CO_2 emissions

A number of Master/Bachelor project themes are available in this area in collaboration with industries. Broadly the topics for project belongs to the following subjects:

- Corrosion resistant aluminium surfaces for automotive applications (SAPA, B&O)
- Optical quality surfaces on aluminium alloys (B&O)
- Self cleaning surfaces on aluminium alloys using photocatalytic TiO_2 (PAJ systemteknik, DTI)
- Microstructure and corrosion of aluminium heat exchanger components (Constellium, France)
- Surface modification of aluminium using steam (Seimens and Dan-colour, DTI)

Exact nature of the project and theme will be formulated in discussion with the students who are interested. Interested candidates, please contact:

Rajan Ambt, ram@mek.dtu.dk or
Morten Jellsen, msj@mek.dtu.dk

Development of porosity in iron-nitrides

Marcel A.J. Somers (somers@mek.dtu.dk)

Description

Porosity in iron-based nitrides is a well known by-product during nitriding and nitrocarburirizing of steels. The driving force for such porosity has been recognized to be the thermodynamic meta-stability of iron nitrides with respect to pure iron and pure nitrogen gas. In this sense porosity could be interpreted as the precipitation of nitrogen gas in the solid state. So far, the actual scientific evidence for N_2 filled pores is missing; all evidence is circumstantial. The present project focuses on proving that N_2 formation is the origin of porosity. Furthermore the kinetics of the precipitation of N_2 will be investigated.

Theoretical work

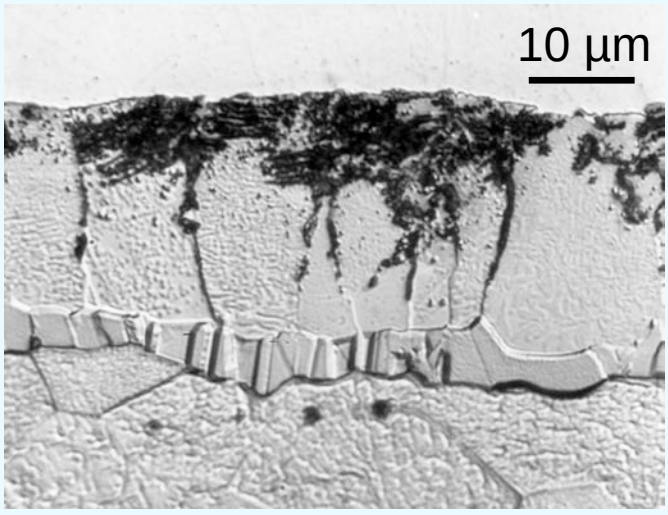
Literature study on porosity and critical evaluation of the various hypotheses put forward to explain this phenomenon. Thermodynamic calculations of the driving force for N_2 development in relation to composition of iron (carbo)nitrides.

Practical work

Synthesis of homogeneous iron nitrides with different nitrogen (and carbon) contents.

Kinetic analysis of decomposition of the (carbo)nitrides with thermogravimetry and differential scanning calorimetry.

Identification of N_2 as precipitates in the solid state with diffraction and or spectrocopic techniques.



Coatings for protection against high temperature corrosion in biomass fired power plants

Trine N. Lomholt (tclo@mek.dtu.dk)

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Description

The aggressive conditions that prevail in biomass fired power plants and waste incinerator call for new materials solutions. The metallic parts are exposed to oxidizing atmospheres containing aggressive chemicals, e.g. halogens, liquid salts etc. Currently, existing plants cannot exceed steam temperatures of more than 540°C due to corrosion problems.

Practical work

The project seeks new formulations of coatings for existing high-temperature materials. This can involve diffusion coatings, thermally deposited coatings (e.g. laser cladding) but can also entail other techniques, e.g. sol-gel derived coatings.
Characterization techniques can involve light optical microscopy, scanning electron microscopy, termogravimetry. Exposure testing in dedicated furnace setup for aggressive atmospheres will be performed.
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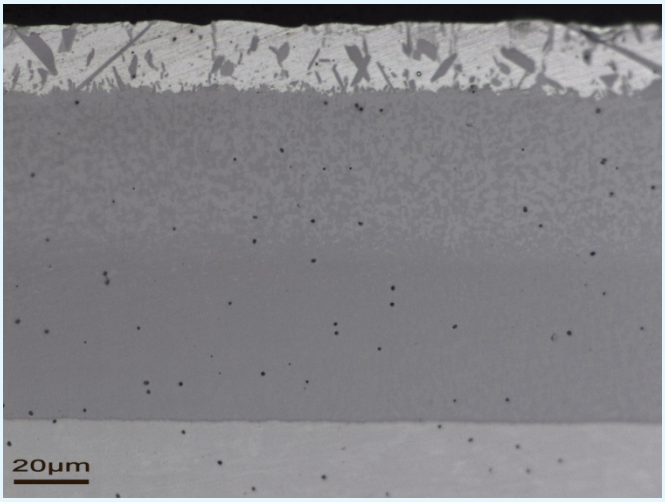

Materials and Surface Engineering
Department of Mechanical Engineering

Surface engineering of metallic implant materials

Thomas L. Christiansen (tch@mek.dtu.dk)

Morten S. Jellesen (msj@mek.dtu.dk)

Up to 20% of the patients undergoing a hip-joint replacement develop peri-implant bone destruction within 10 years after surgery, necessitating revision and replacement surgery. Such implant failure is considered to be strongly correlated with metal release from the implant by corrosion and wear and metal-allergy towards implant components. Longer implant durability and longer lifespan are needed without the risk of rejection of the artificial joint implants. Tailored surface engineering of implants is expected to be an effective means of combating metal release due to corrosion and wear. Surface engineering relies on knowledge of the relationship between implant failure and metal degradation. Ultimately, the aim is to create new biomaterials with high wear and corrosion resistant surfaces to reduce metal release to the human body

Practical work

Surface hardening of in particular CoCrMo alloys will be investigated by thermochemical treatment at low temperature. Other alloys could also be included, i.e. stainless steel and titanium-alloys. The hardened surfaces will be characterized by light optical microscopy, X-ray diffraction, scanning electron microscopy and glow discharge optical emission spectroscopy. Corrosion and tribocorrosion characterization of surface engineered materials will be carried out using electrochemical characterization techniques on modified wear testing equipment.

Materials and Surface Engineering
Department of Mechanical Engineering

Cryogenic treatment of high carbon steels (B.Sc.)

Marcel A.J. Somers (somers@mek.dtu.dk)

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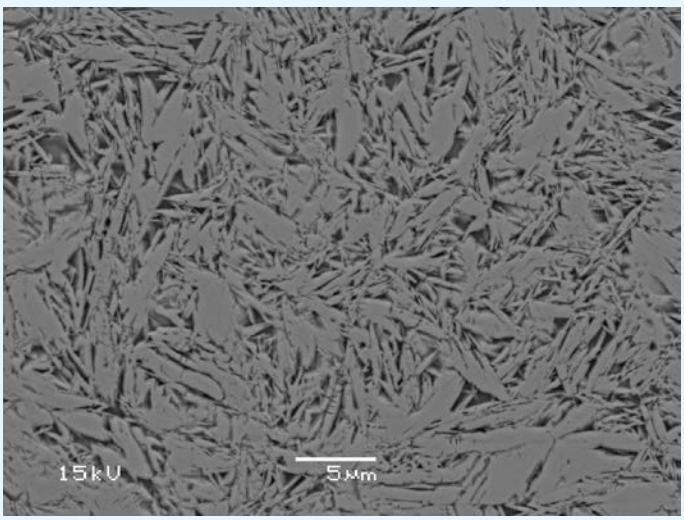
Description

Cryogenic treatments are of industrial importance to improve the mechanical and physical properties of steels such as tool steels, die steels and bearing steels. The beneficial effects of cryogenic treatments are in particular reported to be an improvement in wear resistance up to an order of magnitude, and an increment in tool lifetime up to several times. Negative effects are seldom observed. There is no profound understanding of the reason for the beneficial effect of cryogenic treatment. The metallurgical aspect of cryogenic treatment includes the reduction of the fraction of austenite retained after a conventional quench and an enhanced precipitation of carbides during the subsequent tempering.
Recent work in our group shows that thermally activated martensite formation (as opposed to athermal martensite formation) during cryogenic treatment plays a key role. Different microstructures and characteristics can be obtained varying the thermal cycle during the sub-zero Celsius holding and subsequent tempering.

Practical work

The student will investigate the effect of a few different sub-zero treatments on the final properties of conventionally treated bearing and tool steels. The investigation includes: hardness measurement as a function of tempering temperature; microscopy investigation prior and after tempering; mass loss evaluation as a function of tempering temperature.



Surface engineering of bearings in wind turbine drivetrains

Marcel A. J. Somers (somers@mek.dtu.dk), Kristian Vinter Dahl (kvd@mek.dtu.dk), Ole West (olewe@mek.dtu.dk)

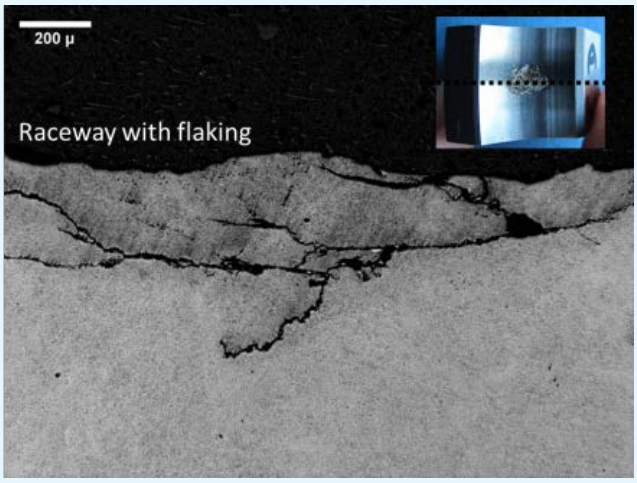
Description

Highly dynamic loads in wind turbines lead to premature failure of metallic components of the drivetrain resulting in considerable economic costs. Therefore it is of high interest to enhance the reliability, extend the lifetime and arrive at an improved life expectancy prediction of these components.
To gain a better understanding of the failure mechanisms in the metallic components in the drivetrain several microscopic techniques have been used to investigate failed components, in particular bearings inside the wind turbine's drivetrain, to characterize the failure mechanisms.
Based on these findings alternative materials and surface treatments need to be evaluated with respect to their potential to improve the lifetime of bearings inside the drivetrain.

Practical work

Various projects can be defined under this umbrella, both M.Sc. and B.Sc. A few suggestions:

- **Development & evaluation of thermochemcial surface engineering treatments as nitriding, carburizing or carbonitriding on appropriate alloyed steels**
- **Rolling contact fatigue testing & analysis of traditional and surface engineered materials**



Materials and Surface Engineering
Department of Mechanical Engineering

Development of anodic electrodes for alkaline electrolyzers (M.Sc.)

Supervisor: Per Møller (pm@mek.dtu.dk)

During the last years the interest for environmentally friendly production of hydrogen has increased. Alkaline electrolysis is considered as one of the few promising near-term techniques suitable for commercialization.
The purpose of your work is to determine suitable material combinations and find processes for manufacturing of oxygen evolving electrodes for alkaline electrolysis. Often the technical focus is only put on the hydrogen overvoltage at the cathode surface. If the overall electrolysis efficiency has to be high, it is also important to reduce the oxygen overvoltage at the anode surface. The final solution has to be a compromise between stability, activity and price.

Project contents (suggested):

1. State-of-the-art literature study with focus on anodic electrodes

2. Deposition of low-overpotential materials

3. Investigate the influence of different anode deposition solutions

4. Electrochemical characterisation

The project is part of a partnership consortium between DTU mekanik, DTU Kemi, Siemens and Green Hydrogen.

Materials and Surface Engineering
Department of Mechanical Engineering

Development of cathodic electrodes for alkaline electrolyzers (M.Sc.)

Supervisor: Per Møller (pm@mek.dtu.dk)

During the last years the interest for environmentally friendly production of hydrogen has increased. Alkaline electrolysis is considered as one of the few promising near-term techniques suitable for commercialization.
The purpose of your work is to determine suitable material combinations and find processes for manufacturing of oxygen evolving electrodes for alkaline electrolysis. Often the technical focus is only put on the hydrogen overvoltage at the cathode surface, which is the subject of this projectThe final solution has to be a compromise between stability, activity and price.

Project contents (suggested):

1. State-of-the-art literature study with focus on anodic electrodes

2. Deposition of low-overpotential materials

3. Investigate the influence of different anode deposition solutions

4. Electrochemical characterisation

The project is part of a partnership consortium between DTU mekanik, DTU Kemi, Siemens and Green Hydrogen.

Materials and Surface Engineering
Department of Mechanical Engineering

Materialekarakterisering af solcremer

Ved vi nok om materialerne i solcremer?

Solcremer anvender forskellige filtre for at sprede og absorbere det skadelige UV-lys. Et af de mest almindelige filtre der anvendes er titandioxid, TiO_2, der tilføres solcremen i meget små partikler (nanometer størrelse). TiO_2 har dog forskellige krystalstrukturer, hvoraf en af disse har den egenskab, at når det belyses med UV-lys dannes der kraftigt oxiderende specier nær dets overflade. Dette gør, at materialet populært sagt brænder alt af der findes i dets overflade, hvorfor man også ofte anvender TiO_2 til at lave selvrensende og anti-mikrobielle overflader.
Til mange formål anvendes TiO_2 i en "stabiliseret" tilstand, hvor der er påført en tynd, inaktiv, belægning uden på TiO2 partiklerne, sådan at den fotokatalytiske effekt undgås eller nedsættes. Der findes dog pt. ikke nogen lovmæssig regulering af hvilken type TiO_2 der skal anvendes i solcremer, ej heller findes der krav til hvorvidt partiklerne skal belægges med en mindre reaktiv belægning.
Dette projekt ønsker at foretage en materialekarakterisering af det TiO_2 der anvendes i solcremer på det danske marked, samt foretage en indledende karakterisering af den fotokatalytiske aktivitet. Denne viden vil være første skridt mod at identificere hvorvidt der potentielt eksisterer et sundhedsmæssigt problem ved brugen af TiO_2 i solcremer, og åbne for evt. videre forløb hvor videre materiale karakterisering og lægevidenskabelige risikovurderinger foretages.

Projektet kan formuleres som bachelor eller eksamensprojekt.

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