



Tillsammans på väg mot en fossilfri och cirkulär industri

Magnus Andersson

Business area manager Material development

”Swerim bedriver industrinära forskning och utveckling kring metaller och deras väg från råmaterial till färdig produkt.”



” Vår vision
är en fossilfri
och cirkulär
industri.”



Kort om Swerim

- Oberoende industriforskningsinstitut
- Cirka 190 medarbetare
- Två huvudorter: Luleå och Stockholm
- Omkring 280 miljoner kronor i omsättning
- Unika test- och demonstrationsanläggningar
- Kunder över hela världen
- Ägs av industrin (80%) och RISE (20%)

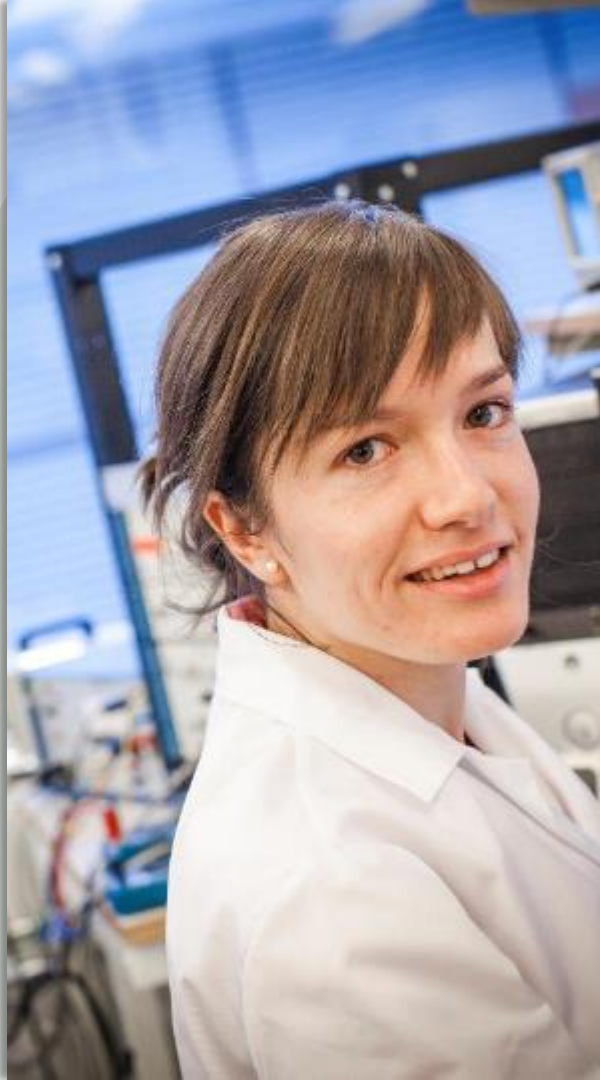


Lång tradition – den äldsta delen grundades "Metallografiska institutet" (1921) samt MEFOS (1963)

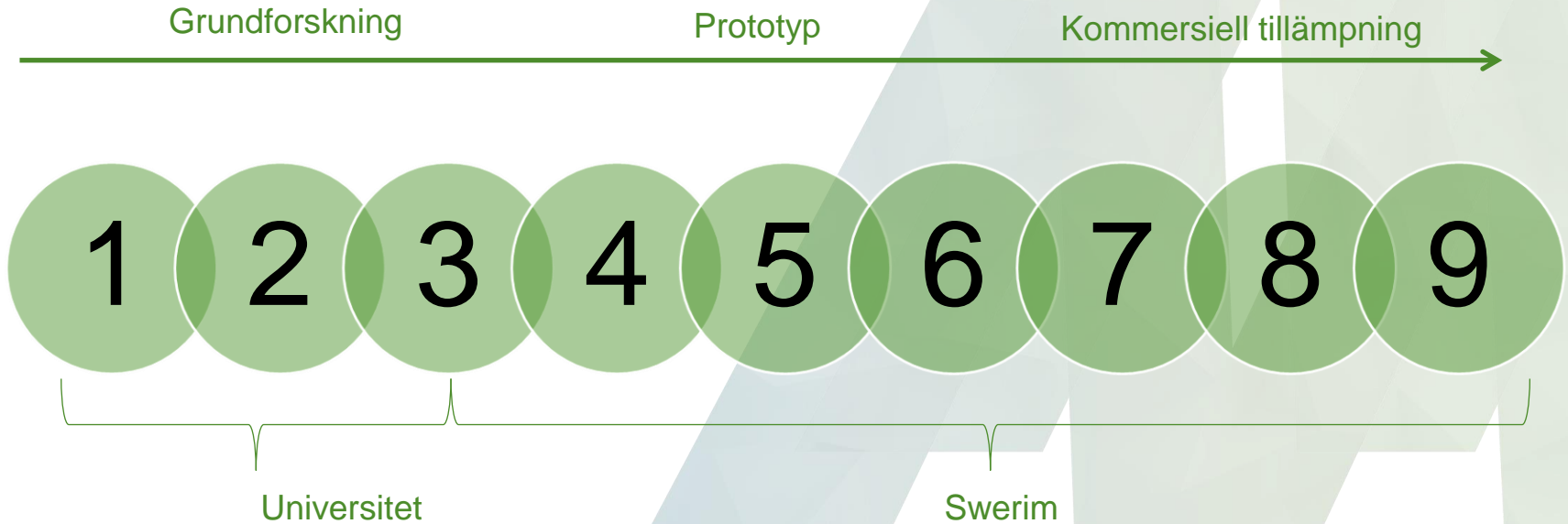
Vårt sätt att arbeta

- Industrins behov
- Forskning och utveckling, kort och lång sikt
- Sekretess
- Oberoende part

- Forskningsprogram
- Nationella och internationella program
- Korta och långa uppdrag
- Partnerskap
- Utbildning och träning
- Mötesplats



Forskning på höga TRL-nivåer



Organisation



Metallurgi

Metallurgi



Mikael Larsson
Affärsområdeschef

CO2 neutral industri

Ida Heinz
Gruppchef



Processutveckling

Johan Björkvall
Gruppchef



Återvinning och miljö

Chuan Wang
Gruppchef



Råmaterial & kvalitet

Pavel Ramirez Lopez
Gruppchef

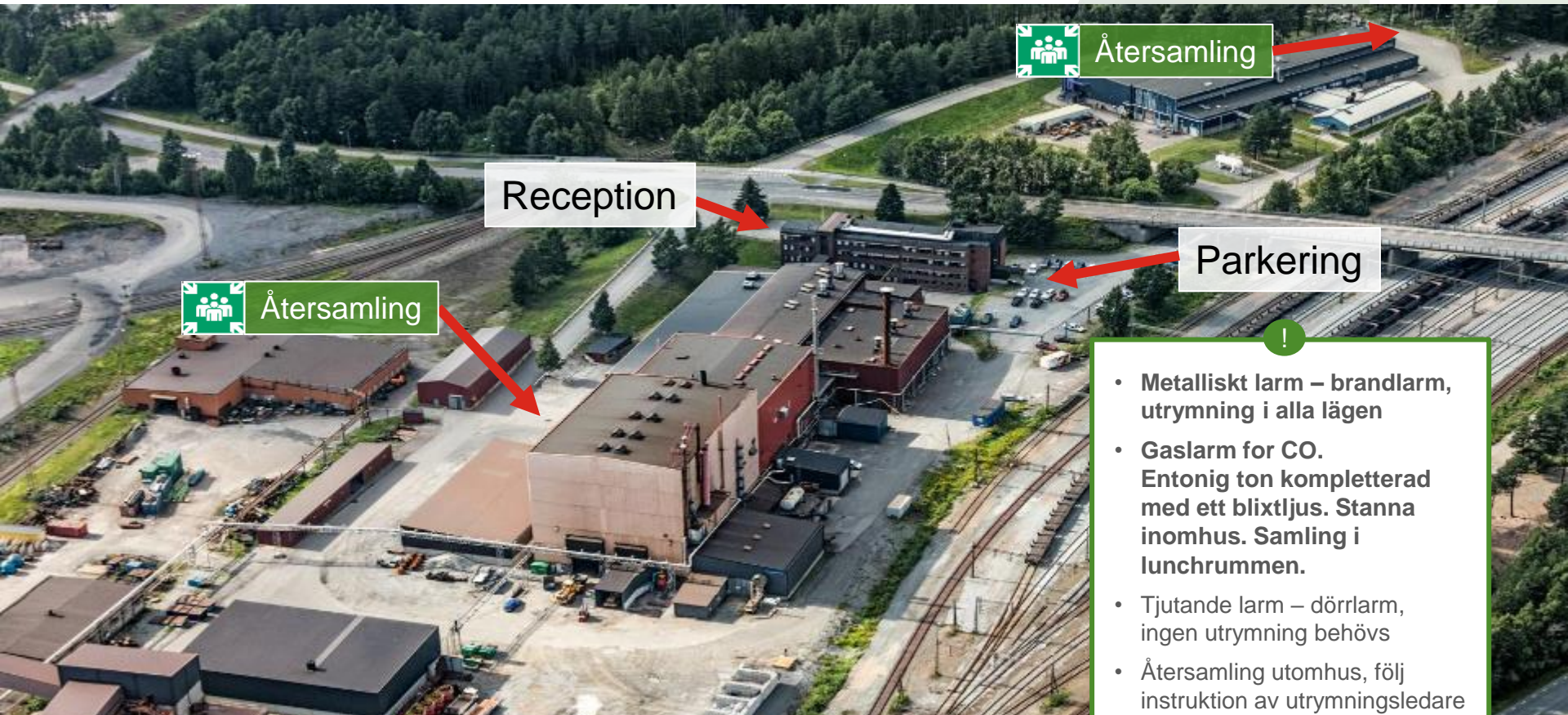


HYBRIT labs

Johan Martinsson
Gruppchef



Utrymningsvägar



Återsamling

Reception



Återsamling

Parkering



- Metalliskt larm – brandlarm, utrymning i alla lägen
- Gaslarm för CO. Entonig ton kompletterad med ett blixtljus. Stanna inomhus. Samling i lunchrummen.
- Tjutande larm – dörrlarm, ingen utrymning behövs
- Återsamling utomhus, följ instruktion av utrymningsledare

Pilot och Demo

Pilot och Demo

Daniel Palo
Affärsområdeschef



Processingenjörer/Säkerhet/inköp

Pilot och Demo Luleå Tekniker

Marcel Magnusson
Gruppchef



Pilot och Demo Kista Forskningsingenjörer

Henrik Östling
Gruppchef

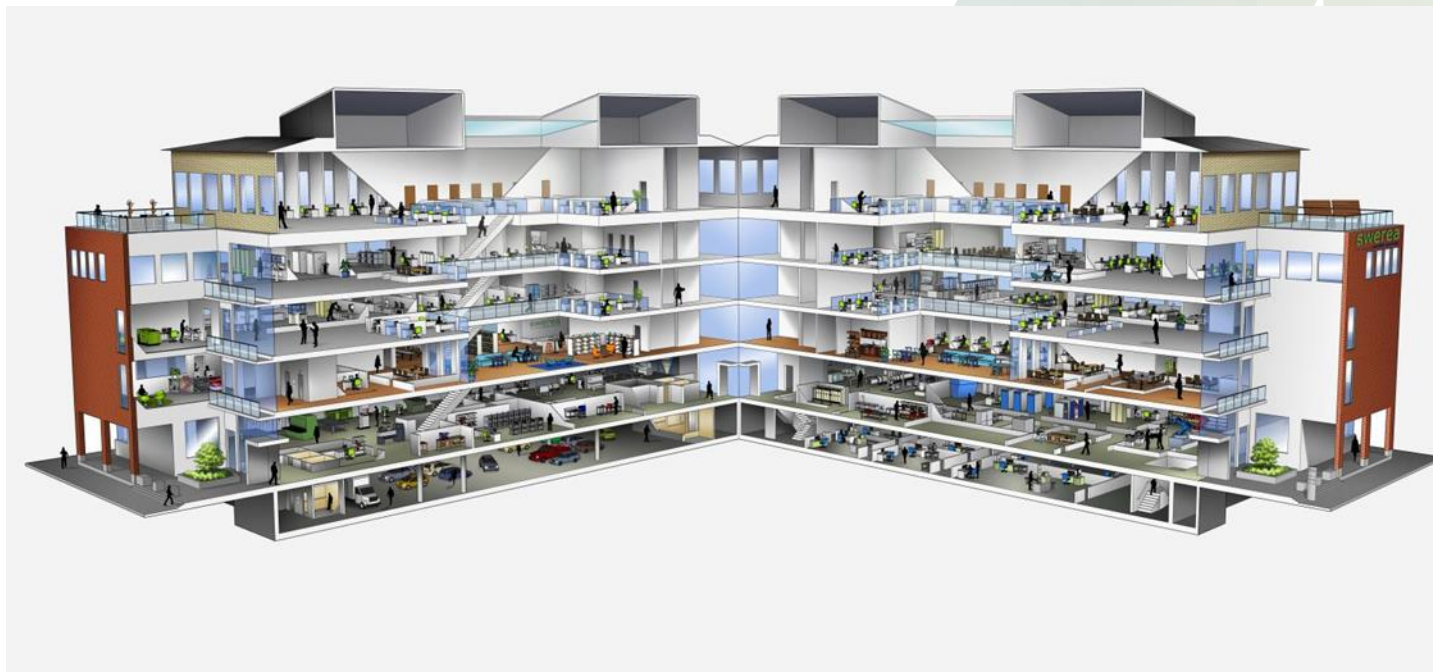


El Instrument & automation

Konrad Långdahl
Gruppchef



100 forskare & avancerad experimentell utrustning



Organisation

♀ 13
♂ 32

Materialutveckling



Magnus Andersson
Affärsområdeschef

Termomekaniska
processer &
ämnesgjutning

Erik Claesson
Gruppchef

Pulvermaterial &
Additiv Tillverkning

Annika Ströndl
Gruppchef

Strukturer i
metalliska material

Shirin Nouhi
Gruppchef

Korrosion och
väteförsprödning

Nuria Fuertes
Gruppchef

Legeringsutveckling

*Niklas Holländer
Pettersson*
Gruppchef

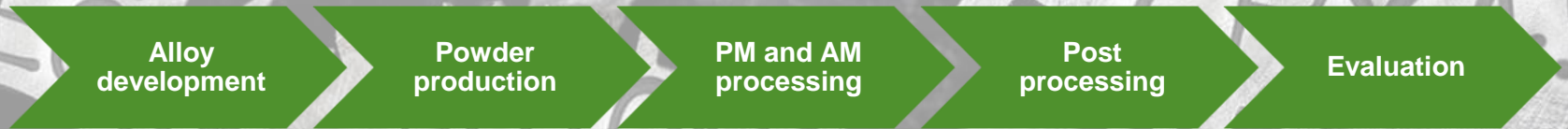


Materials development along the value chain

Conventional



AM/PM



Våra verktyg & testbäddar

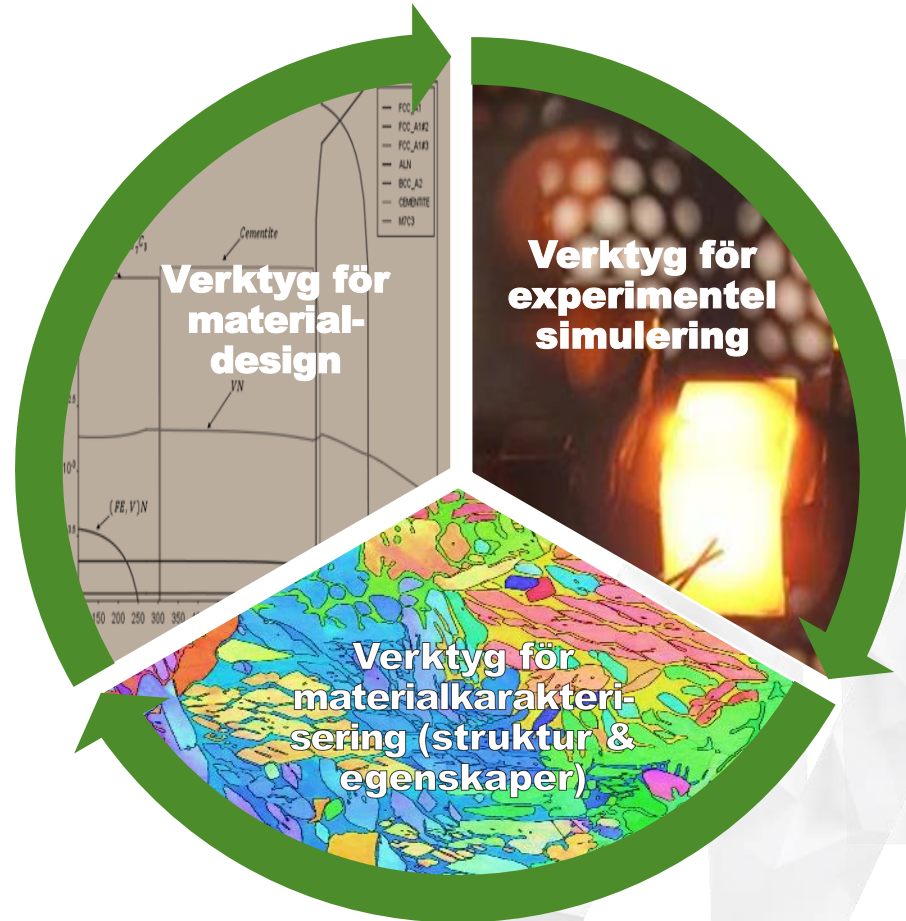
Verktyg för materialdesign

Produktion i labbskala

- ✓ Bearbetade produkter
- ✓ Pulverbaserade produkter

Mikrostruktur, egenskaper

Internt, i samarbete, planerat



Tools

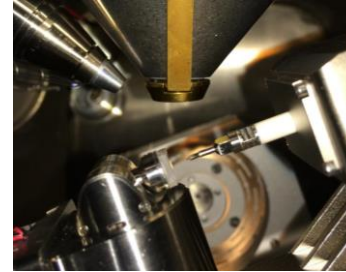
Light
microscopes



SEM/EDS/EBSD/WDS



Nanoindentation
In-situ

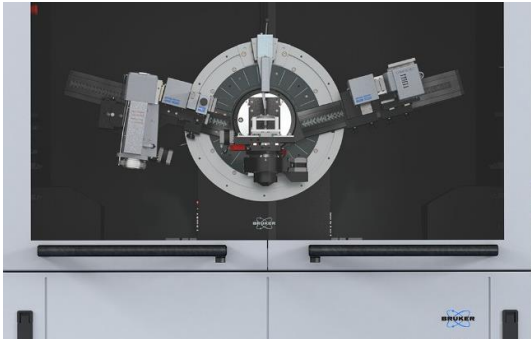


TEM,
SPED



Responsible for light optical, electron microscopy and X-ray diffraction laboratories
We utilize a toolset available in-house and externally, currently highly focused on virtual tools, neutron and synchrotron facilities

Data analysis,
statistics and machine
learning methods



X-ray diffractometer
In-situ tensile tester



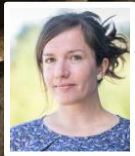
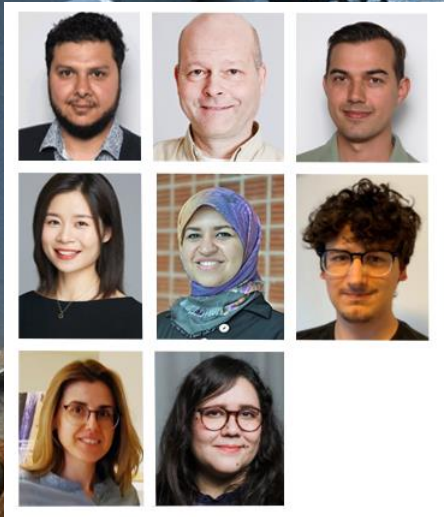
LSI



Corrosion and Hydrogen Embrittlement Group

9 researchers

3 main research fields



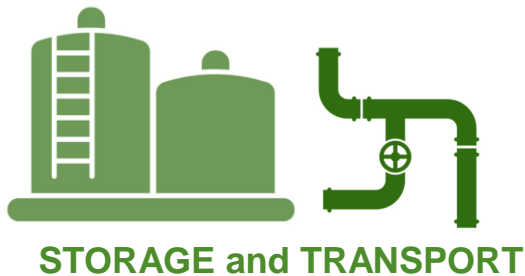
Swerims work in the field of corrosion and hydrogen

SWERIM

- Understanding how corrosion processes intersect through the coupling **material - microstructure - environment**
- Corrosion during **manufacturing, processing** and in **end-user** environments
- Advanced **characterization** of **materials** and **surfaces** as well as possibilities to predict material behaviours based on **thermodynamic calculations**.
- Wide range of **materials**: stainless steels, aluminium, nickel base alloys, high strength steels, copper, tool steels, AM



Effect of H₂ on material properties



AUTOMOTIVE

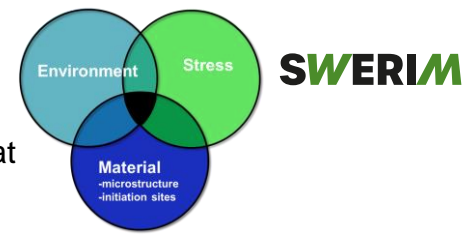


POWER GENERATION
and
HEATING TECHNOLOGIES

Factors affecting hydrogen embrittlement:

- Gas pressure
- Gas composition
- Exposure time
- Temperature
- Type of metal
- Surface conditions
- Deformation
- Welded parts

Focus area Hydrogen



- Hydrogen reduce the ductility of metals and may lead to sudden pre-mature failure even at stress lower than the yield strength = **hydrogen embrittlement (HE)**

We investigate the effect of:

1. Hydrogen source:

- Manufacturing (e.g. coating, welding)
- In-service = corrosion/hydrogen environment

2. Hydrogen interaction with microstructure

- Trapping (defects, trapping sites (carbides))
- Hydrogen solubility and mobility

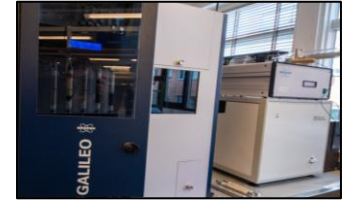
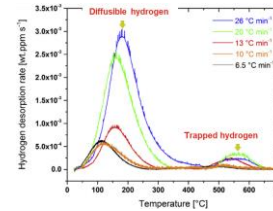
3. Effect of deformation/residual stresses (LSI)

4. Effect of coatings (Zn/ AlSi coating, etc.)

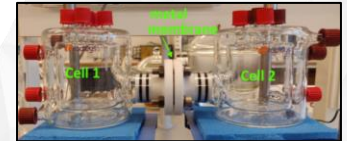
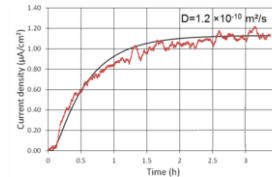
Evaluation by:

- Hydrogen quantification by TDMS** (*Thermal desorption spectroscopy coupled with mass spectrometry*)

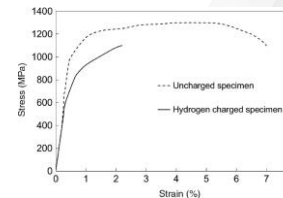
- Diffusible
- Trapped
- Total
- detection limit: 10 ppb



- Hydrogen permeation** by Devanathan-cell



- Mechanical degradation** due to hydrogen by constant load test, SSRT, U-bends



New

Research Consortium at Swerim

Hydrogen Gas – Process and metals

PROCESS + METAL INDUSTRY + END USERS

 15 KSEK/year
MEMBERSHIP



Business Intelligence

Spreading of results
Exchange with other networks



Exchange of experience

Annual physical workshop
4-6 webinars



Research development

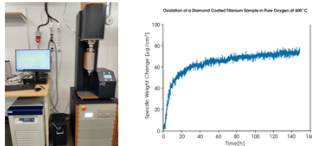
“ask a researcher”
Generation of new projects

Focus area High Temperature Oxidation

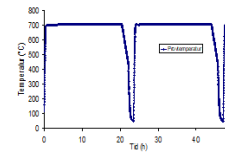
Laboratory exposures:

- Tube furnaces (isothermal and cyclic testing)
- TGA

- Temperature: 0-1500 °C
- Environments: molten salts, CO, CO₂, SO₂, HCl, H₂O, H₂, N₂, O₂, etc.
- Possibility to connect exhaust to MS for gas analysis
- TGA instrument with magnetic suspension balance with automatic drift correction



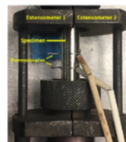
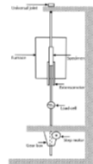
1. TGA machine / weight-time curve



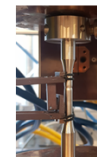
2. Tube furnaces and cyclic testing

Mechanical load + High temperature + High Pressure testing (300 bars)

- Creep, tensile, compression, fatigue (induction heating for cyclic), mechanical fracture
- Temperature: RT-1100 °C
- Environments: SO₂, H₂, air, Ar, etc.
- Pressure: 300 bars



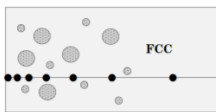
Creep testing at high temperature



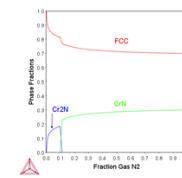
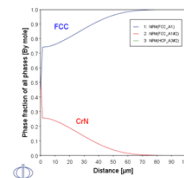
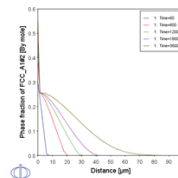
High pressure high temperature testing (HPHT method)

Thermodynamic calculations

- Thermo-Calc
- Dictra
- FactSage

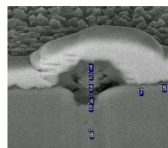


4. Thermodynamic/kinetic simulations

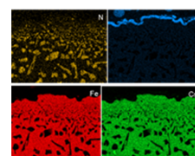


Characterisation techniques

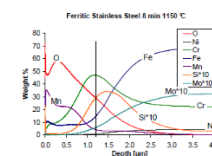
- Mass Spectrometer (outlet gas analysis)
- XRD
- SEM
- TEM
- FIB
- GD-OES
- MS
- TDS
- XAS and XPS – in-situ measurements at high temperatures and in controlled atmospheres



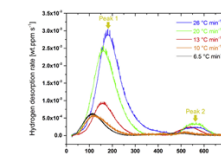
5. FIB oxide cross-section



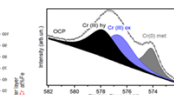
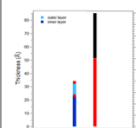
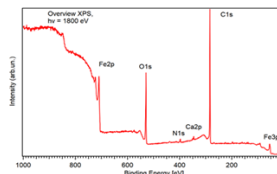
6. EDS mapping



7. Oxide depth-profiling GDOES



8. TDS (N, C)



9. Chemical state and composition analysis with X-rays

Produktionsteknik

Produktionsteknik



Tania Irebo Schwartz
Affärsområdeschef

Fogning

Alexander Lundstjälk
Gruppchef



Mekaniska egenskaper, skärande bearbetning & komponentvärmebehandling

Jonas Jordberg
Gruppchef



Materialanalys & processövervakning

Peter Lundin
Gruppchef



Värmning och bearbetningsteknik

Stefan Marth
Gruppchef



Värmebehandlingscentrum

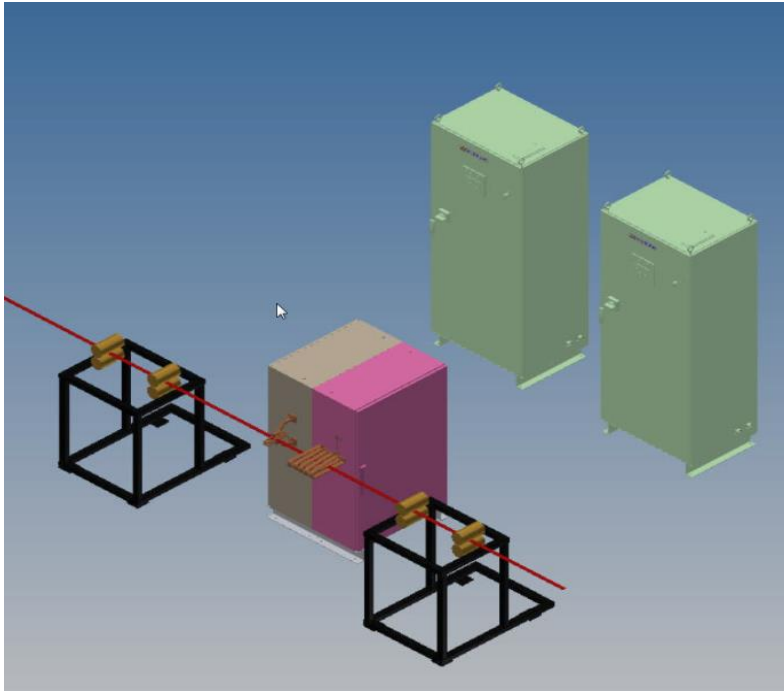
- Start 2006
- FoU-utförare: RISE och Swerim
- Medlemsföretag
 - Scania, Volvo, Epiroc, EFD Induction, GKN Driveline, Teknoheat, Linde Gas, Bodycote, Parker Hannifin, Ovako, Sandvik Mining, SKF, CalorMet, Curtiss-Wright och LEAX Group
- Programforskning - finansieras av företagsinsatser (2/3) och SK-medel (1/3)
- Medlemsavgift: 18 750 – 75 000 kr/andel och år (2 - 3 andelar → medlem i styrgruppen)
- Tyngdpunkt på **tillämpad forskning** och utveckling av dagens processer och produkter samt nya alternativa processer.
- Processer som avses är **sätt-, genom- och induktionshärdning, nitrering/nitrokarburering** och eventuella för- och efterbehandlingsar.
- 22 ▪ Omvärldsbevakning, informationsspridning och kompetensutveckling.
- Större projekt, som offentligt finansierade och EU-projekt genomförs inom ramen för VBCentrum.





Pilotutrustning induktionshärdning Experiment & modellering Swerim Luleå

Experimental setup



2 GENERATORS TA100

- Frequency range 20 – 100 kHz (35 kHz)

2 OSCILLATORS

- switchable voltage and capacitance

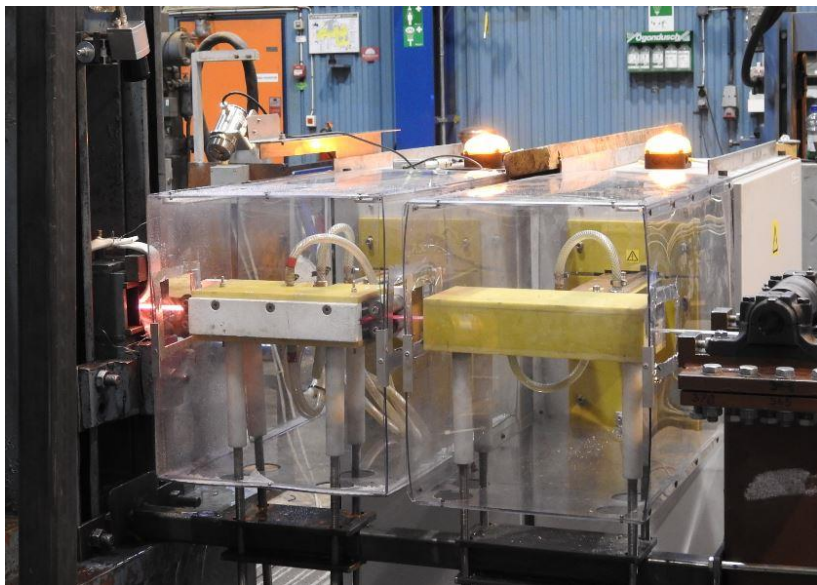
2 INDUCTORS

- One for longitudinal heating and one for cross-field heating

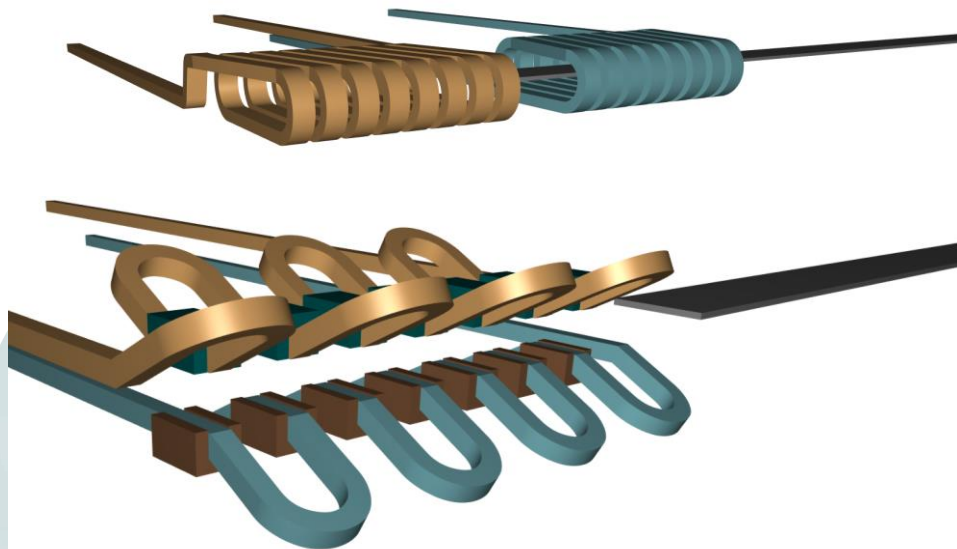
COOLING SYSTEM

- Closed system med conductivity meters och deionization

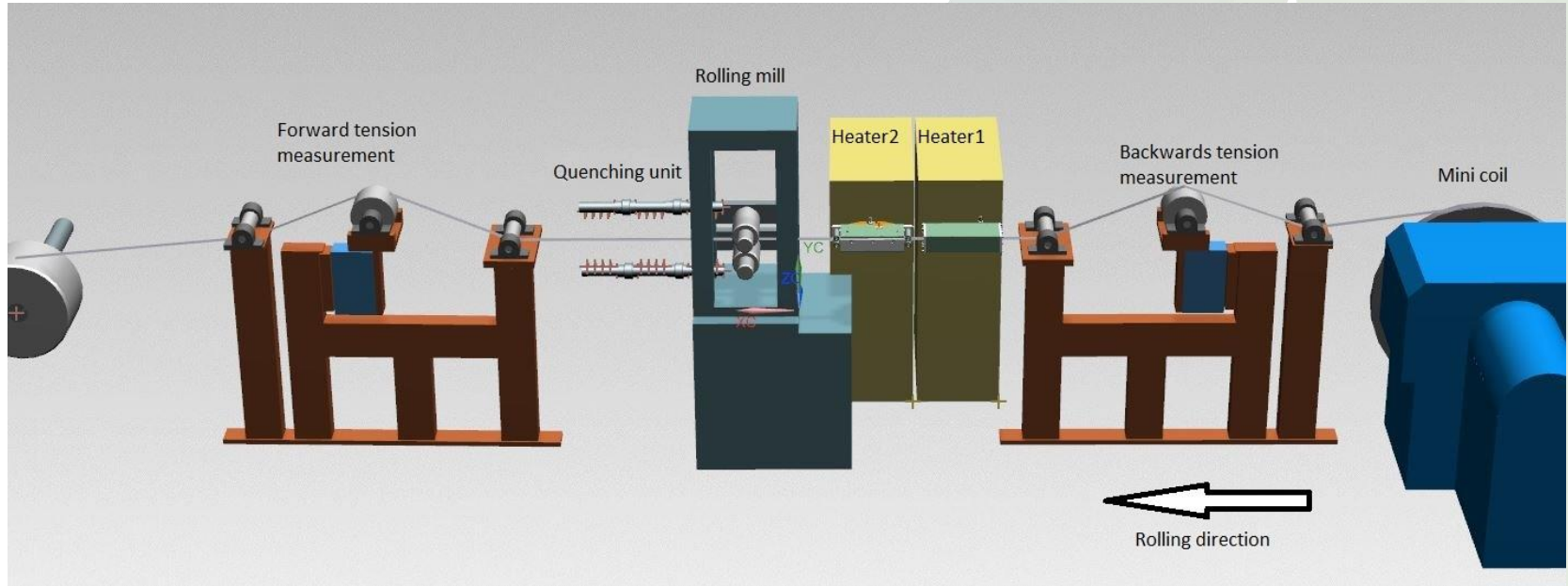
Inductor design - longitudinal and cross-field heating



Inductor



SWERIM's process line for inductive heating / rolling / quenching





SWERIM

Vi skapar industrinytta