Jönköping University, School of Engineering, Sweden

SCHOOL OF ENGINEERING
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Foundry Technology Education ”Foundry stairs”

PhD
School of Engineering Jönköping University

M Sc
School of Engineering Jönköping University

B Sc
Foundry Engineer
School of Engineering Jönköping University

Foundry operator
Foundry Technican
KY- education

- Courses at companies
* Short courses in Jönköping
* Sommer school
- University course
- Seminaries / Conferences

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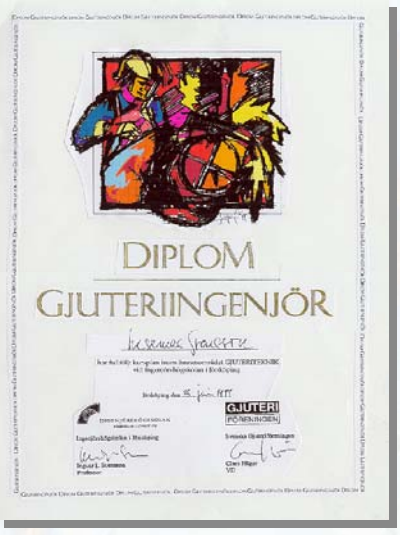
Dipl. Foundry engineer



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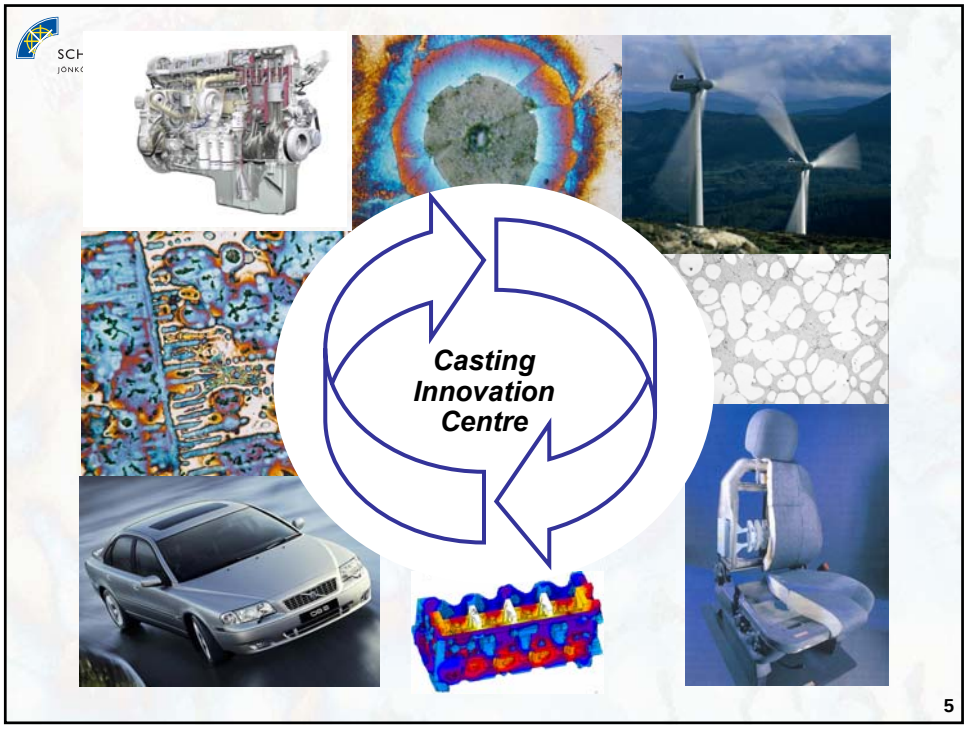

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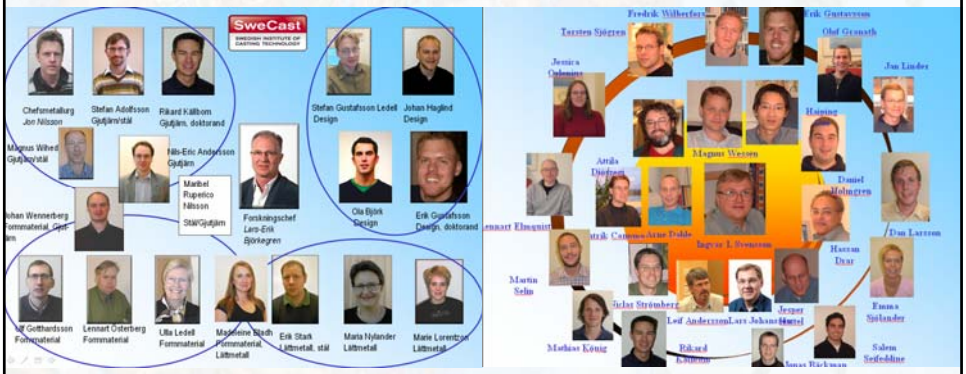
Personal at CIC



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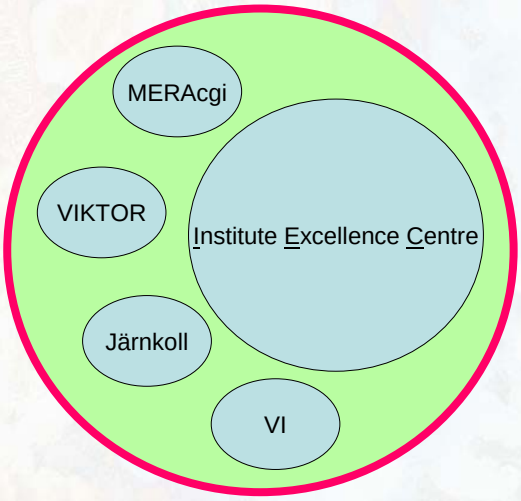
Casting Innovation Centre

School of Engineering



SweCast

Projects in the Centre

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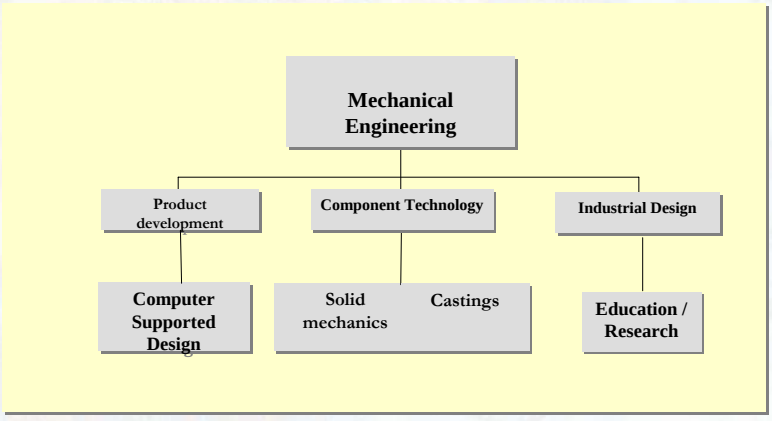
Jönköping University
Department Mechanical of Engineering
Component Technology-Castings



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Fundamentals in Castings

- Fluid Dynamics
- Solid mechanics
- Fracture
- Material Science
- Materials Technology
- Modelling and Simulation

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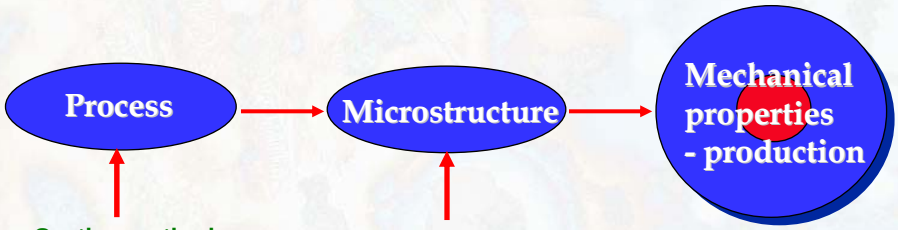
Research

Process – microstructure / defects – mechanical properties - production
Experiments – modelling - simulation



Casting method
Filling and
Heat Extraction

Fe- Al- and Mg-alloys
Semi-solid materials
Metallurgy
Modification
Grain refinement Inoculation
Gas content
Defect formation
etc...

Fe- Al- and Mg-alloys

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Examples of research areas

- Porosities
  - Microporosities
  - Shrinkage porosities
- Microstructure
  - Fraction of phases /structure
  - Different phases /structures
  - Microstructure morphologies
  - Coarseness
- Mechanical properties
  - Ultimate tensile strength
  - Yield strength
  - Ultimate elongation
  - Fatigue
- Thermal properties
- Process and Productivity
- Mould filling defects
- Thermal residual stresses / deformations etc.

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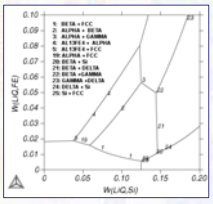
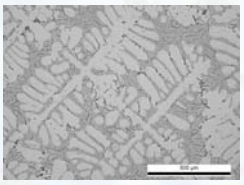
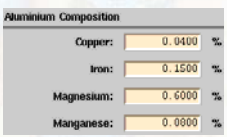
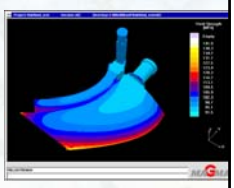
Development of cast material properties, modeling and simulation









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Staff

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Summary - Project list

Aluminium


Emma Sjölander


Salem Seifeddine


Jan Linder


Dan Larsson

–NADIA, "New Automotive components, Designed for and manufactured by Intelligent processing of light Alloys" , 1 PhD students

–VILMER, weight efficient components
1 PhD students

–ALPOR Features of the fatigue properties for aluminium castings,
1 PhD student

–VIKTOR Simulation of local material properties,
1 PhD student

-FE-modelling of defects in a cast aluminium alloy
Part time PhD student

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Summary - Project list

Magnesium

Olof Granath

–An Innovative technology for light metals semi-solid feedstock production (RFS-technology),
PhD student

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Summary - Project list

Jessica Orlenius

Mathias König

Lennart Elmquist

Torsten Sjögren

Martin Selin

Rikard Källbom

Fredrik Wilberfors

Dan Larsson

Cast Iron

–MERAcgi, Optimized materials for robust metal cutting of compacted graphite cast irons.
PhD student

–JÄRNKOLL, Quality control of iron melts, 2 PhD students

–Developing and Controlling the Properties in Cast Irons From the Microstructure, PhD student

–Engineering design- material- and processdevelopment of high-performing cast iron components for environmental friendly combustion engines, part III.
PhD student

– CHUNKY Improved graphite morphology in heavy section ductile cast iron, PhD student

–PROPIRON Prediction of properties of cast,
PhD student

–VI, Ductile Iron, ADI
PhD student

–METRO: Metallurgical TRaining On-line Pilot Project

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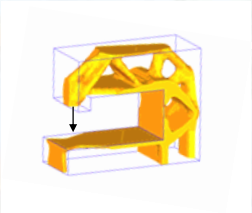
Summary - Project list

Niclas Strömberg

Erik Gustafsson

Magnus Hofwing

Applied Mechanics and Optimization



Project leader: N. Strömberg
(supervisor)

Ph.D.-students: E. Gustafsson
M. Hofwing

Projects:

-Shape optimizations of castings
(E. Gustafsson, N. Strömberg, initiated: 2004-11-01)

-Topology optimization of stamping dies
(M. Hofwing, N. Strömberg: initiated: 2006-12-01)

-Topology optimization of thermoelastic structures
(N. Strömberg)

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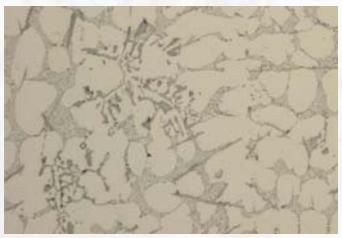
NADIA, "New Automotive components, Designed for and manufactured by Intelligent processing of light Alloys"

Emma Sjölander

Salem Seifeddine



The aim of the project is to measure and model mechanical properties and thermal conductivity of as-cast and heat treated aluminium alloys.

The thermal conductivity will be measured, both for application purposes and as a tool to understand the sequence of precipitation formation.

Three commercial alloys (A319, A354 and A356) and material from a cylinder head will be investigated.

Keywords: Aluminium alloys, mechanical properties, thermal conductivity, heat capacitivity, thermal expansion, gradient solidification, heat treatment, precipitation, modelling

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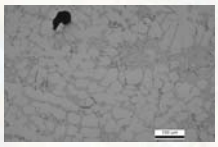
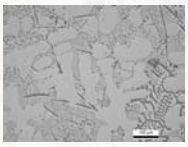
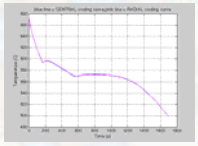
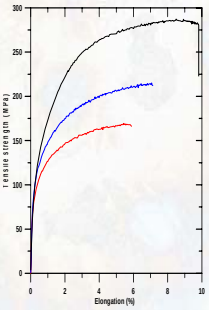
Prediction of microstructure and mechanical properties of Al-Si cast alloys (VILMER)


Salem Seifeddine Ingvar L Svensson

The main goal is to establish a quantitative prediction of mechanical properties of aluminium cast components through process simulation based on microstructural modelling approaches.

The studied material is based on commercial components and through systematically designed casting experiments with alloys containing various Si, Mg, Cu, Fe and Mn concentrations solidified under a wide range of cooling conditions using gradient solidification technique.

Keywords: Al-Si, cast processes, microstructure, iron-rich compounds, mechanical properties

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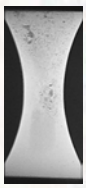
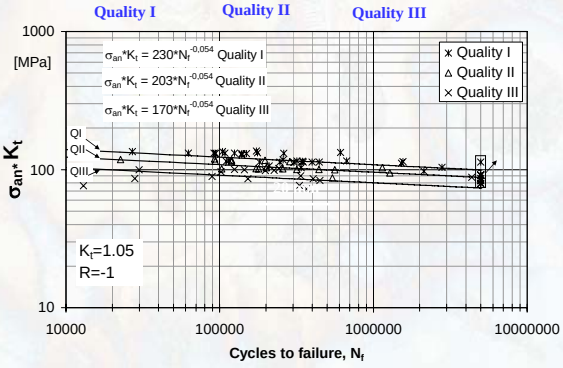
ALPOR Features of the fatigue properties for aluminium castings





Quality I Quality II Quality III


Jan Linder Ingvar L Svensson



The use of linear elastic fracture mechanics to assess the influence of environment and porosity on the fatigue strength for engineering materials.

For the high pressure die cast aluminium alloy the environmental influence of fatigue initiation through pre exposure of smooth specimens was studied.

Keywords: Stainless steel, cast aluminium, hardened steels, fatigue, corrosion, crack propagation, spot weld, porosity

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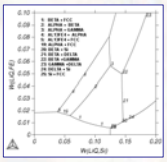
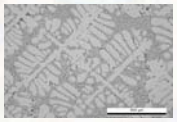
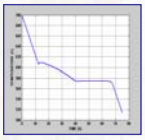
Virtual produkt development for cast components (VIKTOR)

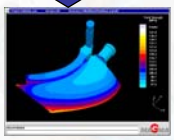

Dan Larsson

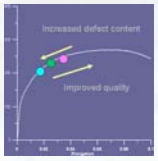

Ingvar L Svensson











The aim is simulation and modelling of local material properties to develop methods, material data and verifying material models for simulation to reduce the need of physical prototypes and physical testing.

Keyword: Aluminum, cast iron, ductile iron, gray iron, modelling and simulation, mechanical properties, microstructure, local material parameters, plastic deformation, static testing

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Weigth and volume intelligent cast constructions (VI)


Dan Larsson


Ingvar L Svensson

The goal is to build up knowledge of the entire productionchain from design and material selection to manufacturing, heat treatment and machining.

Charterization of static mechanical properties of some heat treatments of ADI material

Keyword: ADI, modelling and simulation, mechanical properties, microstructure, local material parameters, plastic deformation, static testing

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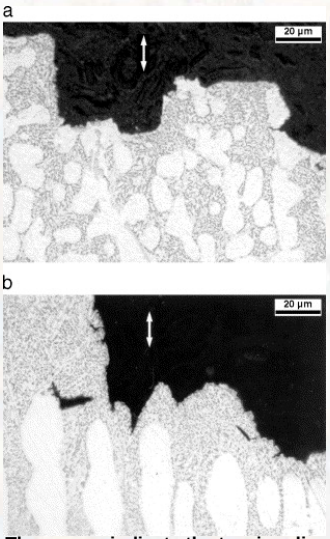
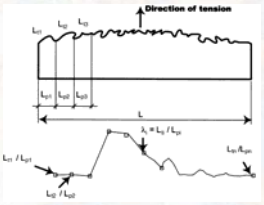
Characterization of tensile fracture in directionally solidified Al–Si alloys using linear roughness index





Hassan Drar

The arrows indicate the tension direction. (a) DC, R_L = 3.12, ε_F = 0.85%; (b) DS, R_L = 1.89, ε_F = 11.05%.

<u>The main goal</u> is to integrate the fractography as a tool in understanding the fracture in castings.

The result of changing the casting method on the fracture surface profile is studied.

Keywords: Casting; Deformation and fracture; Mechanical properties; Microstructure; Solidification; Fracture surface profile; Fracture roughness index

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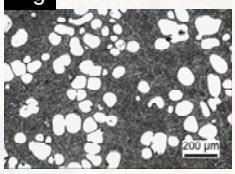
An innovative technology for semi-solid light metal rheocasting and feedstock production (RSF-technology)

Olof Granath

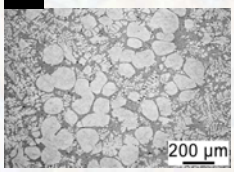
Haiping Cao

Magnus Wessén

Mg



Al



- **Goals: First goal is to obtain and investigate globular microstructures for rheo and thixocasting made by the RSF technology and to understand the mechanisms involved in microstructure formation. Second goal is to investigate mechanical properties of cast components produced by this process.**
- Semi-solid castings have many advantages such as:
  - Favourable die filling
  - Better mechanical properties; mainly because of low defect levels.
  - Longer die life (lower casting temperatures)
- Suitable applications are components used in the automotive industry, etc….
- **Keywords:** semi-solid, RSF, rheocasting, thixocasting, globular microstructure, mechanical properties, grain growth.

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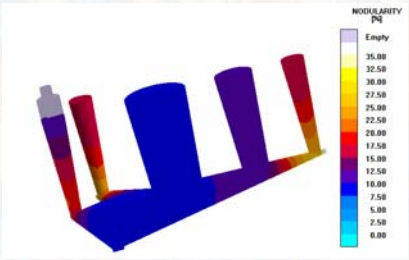
MERA CGI, Optimized materials for robust metal cutting of compacted graphite cast irons.

Mathias König

Magnus Wessén



The main goal is to increase the understanding regarding microstructure variations in a casting depending on different solidification/cooling conditions in compacted graphite iron materials as well as establishing models for simulation of these phenomena.

The increasing environmental demands on truck engines leads to higher demands on mechanical properties than traditional engine materials can satisfy. Compacted graphite iron possesses a number of interesting properties in this context.

Keywords: Cast iron, compacted graphite, nodularity, thermal analysis, simulation, mechanical properties, microstructure

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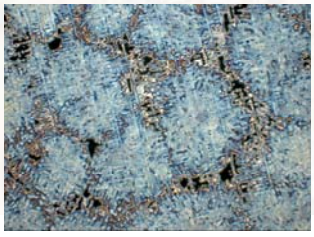
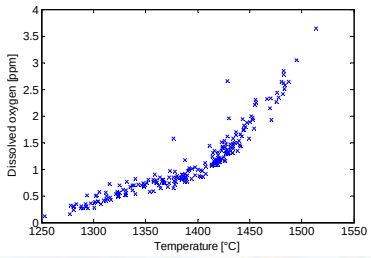
The mechanism of shrinkage porosity formation in Gray Cast Iron



Lennart elmquist

Attila Diószegi



The main objective is to improve the understanding of the influence of microstructure on shrinkage porosity formation in Gray Cast Iron.

The studied materials are related to cast components from the automotive industry, cylinder heads, cylinder blocks, brake disks. Co-operation between Jönköping University, Scania CV AB, SweCast AB and Volvo Powertrain AB

Keywords: Gray cast iron, primary austenite, austenite grains, nucleation, inoculation.

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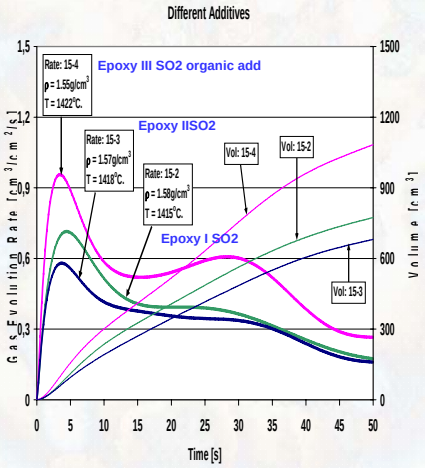
Gas Porosity in Gray Cast Iron (Järnkoll)


Jessica Orlenius Attila Dioszegi



Main goal: **Develop understanding about the foundry process to guarantee the casting quality by minimization of casting defects such as gas porosity**

Co-operation between Jönköping University, Scania CV AB, SweCast AB and Volvo Powertrain AB

Keywords: Cast iron, gas porosity, core and mold gas evolution, gas absorption

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The mechanism of metal expansion penetration


Izudin Dugic Attila Diószegi

The main objective is to improve the understanding of the mechanism of metal expansion penetration formation and Gray Cast Iron.

Complex shaped cast components from the automotive industry like cylinder heads, are studied in combination with special designed samples.

Keywords: Gray cast iron, primary austenite, austenite grains, inoculation.

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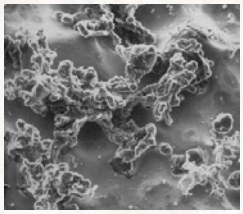
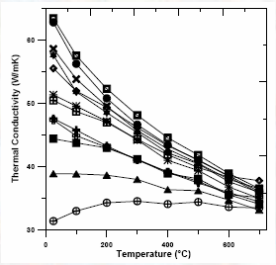
Engineering design- material and processdevelopment of high-performing cast iron components for environmental friendly combustion engines



Compacted graphite cast iron



Martin Selin

Daniel Holmgren

The aim with this project is to obtain improved properties by means of material- and process design in order to facilitate construction of environmentally friendly diesel engines.

Focus will be on thermal conductivity and the mechanical properties of compacted graphite cast iron, CGI. Questions in focus are for example the influences from graphite morphology and the metal matrix on these properties.

Keywords: Cast iron, flake graphite, compacted graphite, spheroidal graphite, thermal conductivity, graphite morphology, Laser Flash

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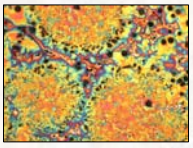
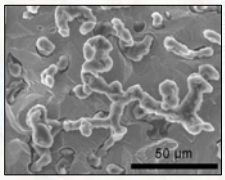
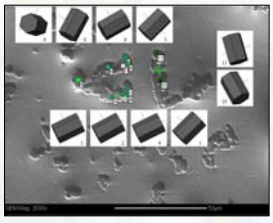
Improved graphite *morphology* in heavy section ductile iron castings







SweCast
SWEDISH INSTITUTE OF CASTING TECHNOLOGY
Member of the swerea Group

Rikard Källbom

Magnus Wessén

Main goals are to avoid the formation of chunky graphite, investigate its influence on the mechanical properties and to improve the understanding of the formation and growth mechanisms.

The research work is important in order to improve ductile iron as a construction material, especially for heavy sections components to the automotive and the wind-mill industries.

Keywords: Cast iron, ductile iron, spheroidal graphite, chunky graphite, crystal growth, trace elements, inoculation.

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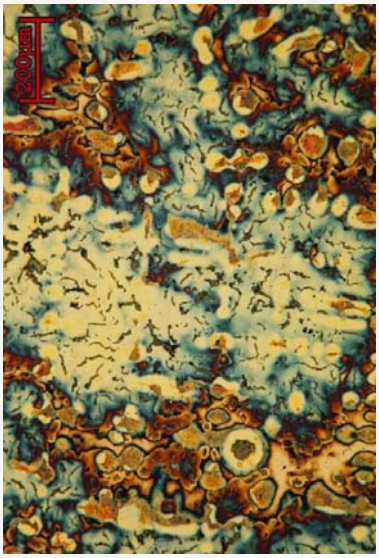
PROPIRON
Prediction of properties of cast iron




Fredrik Wilberfors


Ingvar L Svensson

The aim is to improve knowledge about nucleation and growth of graphite in LGR and CGI.

Mechanical properties of cast iron. More roubust process and mechanical properties in cast iron.

Keywords: cast iron, nucleation graphite, solidification, relation microstructure and properites

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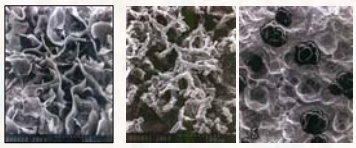
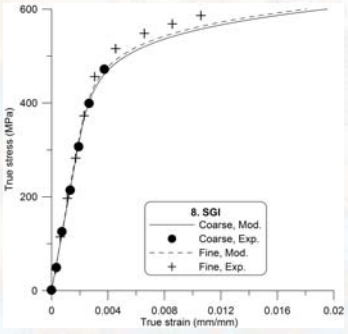
Developing and Controlling the Properties in Cast Irons From the Microstructure






Torsten Sjögren


Ingvar L Svensson

Main goal to improve the understanding of the influence of graphite morphology on the elastic and plastic stress-strain behaviour of Cast Irons

The studied material grades originated from castings for marine diesel engine piston rings with different chemical analyses. Modeling of elastic and plastic deformation related to graphite morphology

Keywords: Cast iron, flake graphite, compacted graphite, spheroidal graphite, elastic behaviour, modulus of elasticity, graphite modulus of elasticity, nodularity, aspect ratio, plastic deformation, acoustic emission

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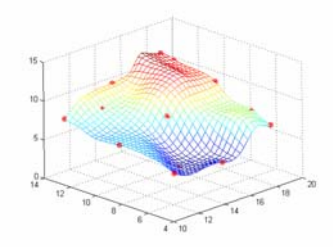
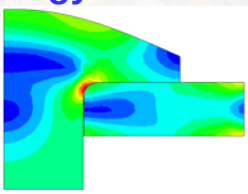
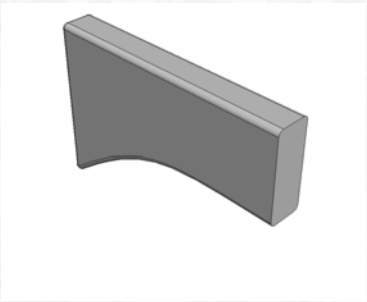
Shape Optimization of Casting by using Successive Response Surface Methodology





Erik Gustafsson

Niclas Strömberg



Main goal of this project is to investigate how residual stresses from the casting process affect the optimal shape of castings. This has also opened up for development of a general optimization method applicable to non-linear mechanics.

In order to study these phenomena an optimization routine that utilizes response surfaces, both analytical and neural networks, has been created. The optimization routine uses Successive Response Surface Methodology as proposed by Stander and Craig with some modifications by Gustafsson and Strömberg.

Keywords: Castings, Optimization, Successive Response Surface Methodology, Neural Networks

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Research and Special equipment

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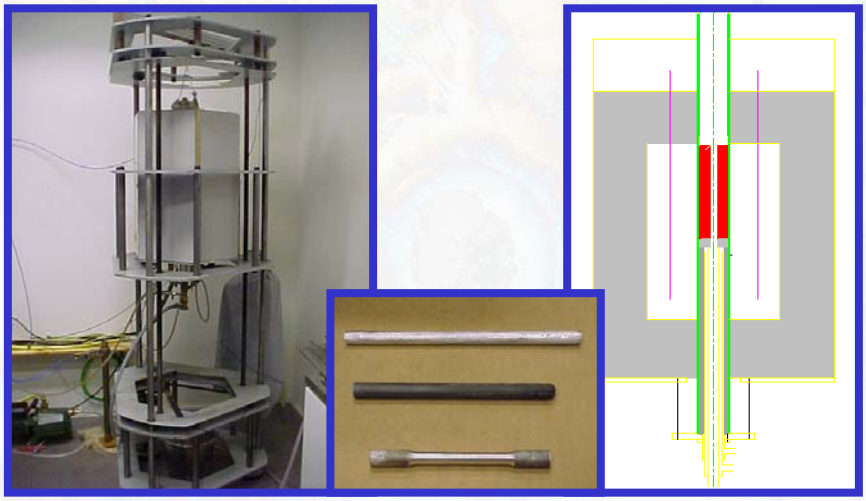
Gradient solidification technics



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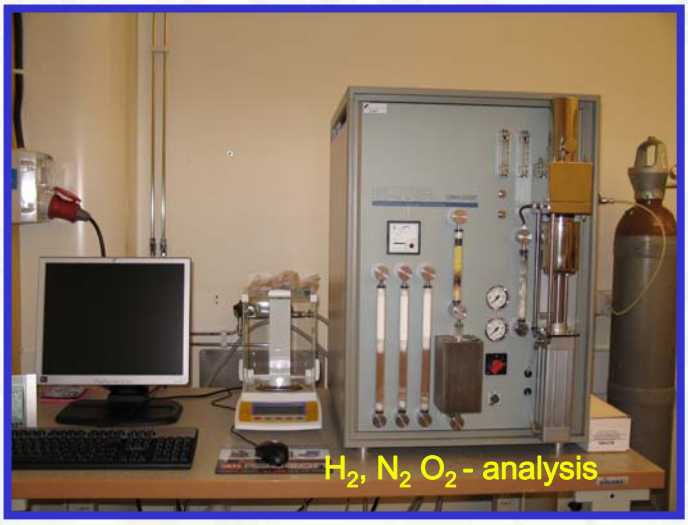
Hydrogen, Nitrogen and Oxygen analysis in metals



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Thermal conductivity

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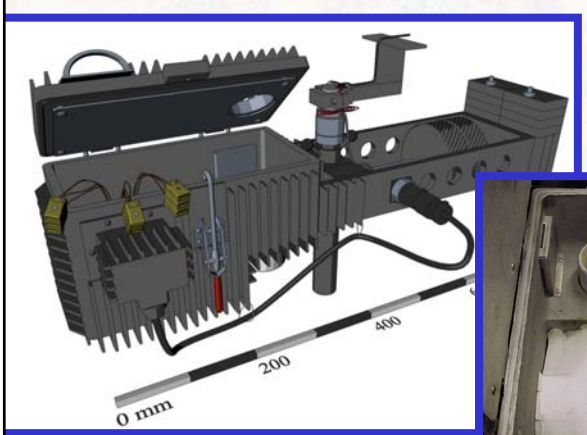
Centrifugal chill casting



- Inert gas, Vaccum, Air

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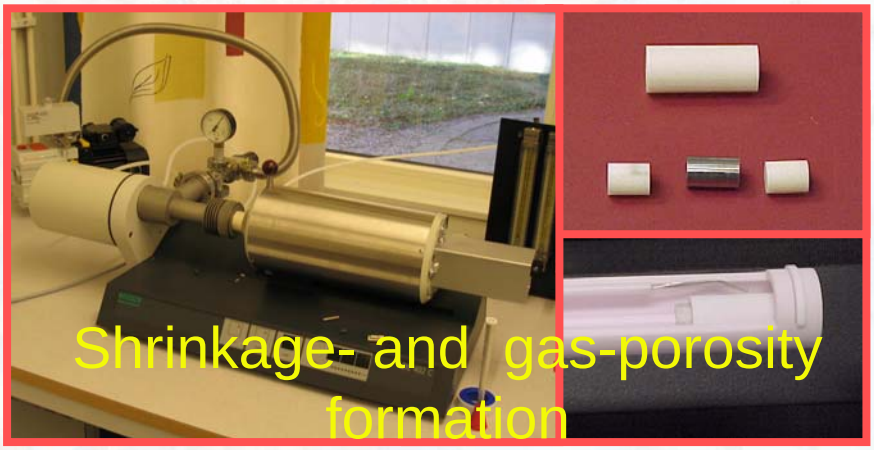
Volume changes



Measurements and modelling of volume and density

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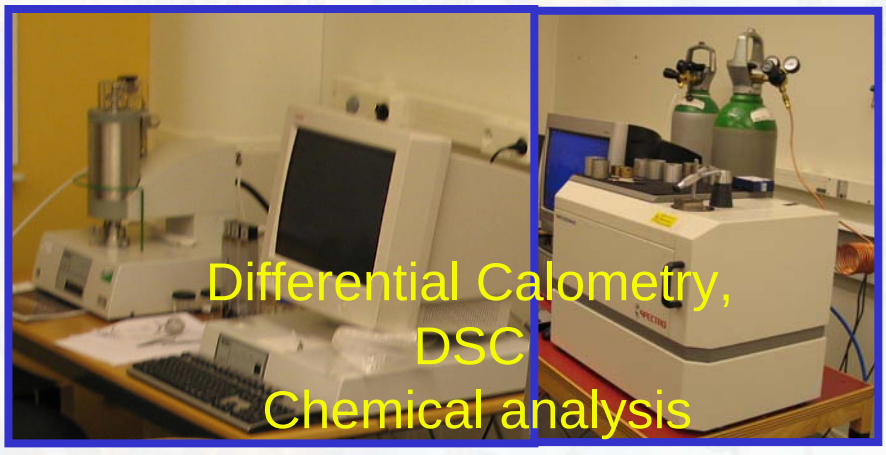
Thermophysical data and chemical composition



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Industry as a casting laboratory

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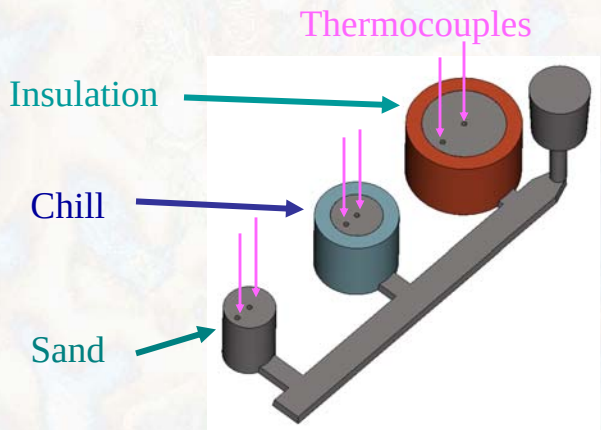
Solidification and transformation studies by thermal analysis



Process parameters:

- Cooling rate
- Alloy
- Inoculation

MULTIPLE THERMAL ANALYSIS

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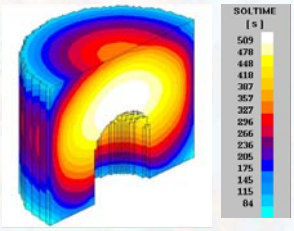
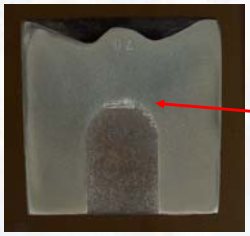
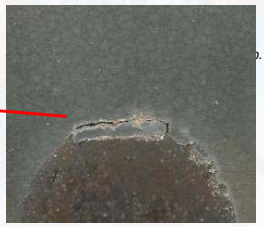
Test cup for investigation of metal expansion penetration mechanism.

Test cup for investigation of metal expansion penetration mechanism



Solidification time of the test cup





Cross section of a penetration test cup

The metallic interface and penetrated metallic strip

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Sample preparation for microscopy

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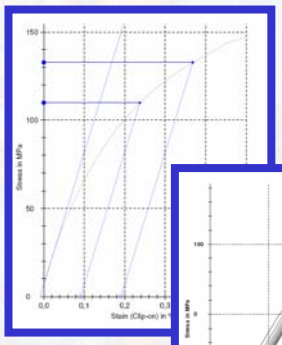
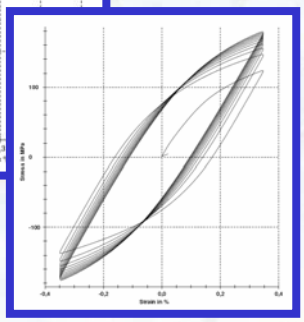
Tensile testing / Mechanical Properties





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Light microscopy

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FEGSEM
Field Emission Gun Scannig Electron Microscope

Field Emmission Electron Scanning Microsopy

EDS

WDS

EBSD

Tensile and heating stage

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Further experimental equipment

- DSC, Differential Scanning Calorimeter
- Tensile testing equipment, hardness macro/micro
- Push rod dilatometer solid/liquid
- Chemical analysis
- Foundry as laboratorium
- Centrifugal casting
- Prototyp workshop
- Etching and metallography
- …

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Thank you for your attention

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