

Neutroner og Røntgen til Industrien

Eksempler fra FORCE Technology og GTS - partnere

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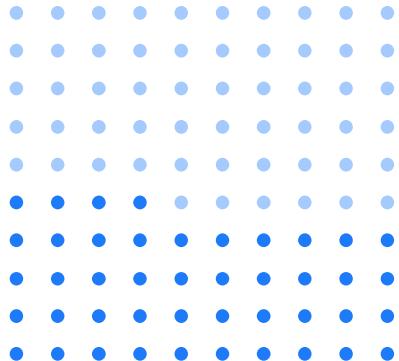
30-04-2025

Nøgletal

2024



1.312 mio.
Omsætning i DKK



Andel af omsætning udland

Næsten halvdelen af FORCE Technology's omsætning stammer fra internationale kunder igennem eksport eller udenlandske aktiviteter.



1.043
Medarbejdere



7.000+
Kunder

Nøgletal

Forskning og udvikling



250+

Unikke faciliteter



5.000+

Kursister og
eventdeltagere



150+

Samarbejdsprojekter



134

FoU projekter i 2024



50+

Discipliner

Godkendt Teknologisk Service (GTS)

Som GTS-virksomhed er vi dedikerede til at udvikle og bruge teknologier og ny viden til gavn for erhvervsliv og samfund som helhed.

GTS-institutterne er sat i verden for at gøre det muligt for flere virksomheder at anvende ny forskning og teknologi.

I kraft af teknologiske kompetencer og state-of-the-art faciliteter løser GTS-institutterne konkrete problemer for virksomheder. Det skaber innovation, vækst og arbejdspladser.

Hvert år bistår GTS-institutterne op mod 30.000 virksomheder.

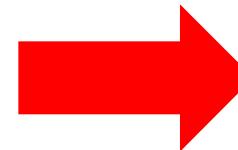


FORCE Technology materialekarakterisering

- Typiske kommercielle services for industrien
 - Fremmedlegemeidentifikation – Hvad er det?
 - Materialeidentifikation – Lever det op til specs?
 - Materialetests – Hårdhed, brudstyrke, ...
 - Havarianalyser – Årsag til brud, brand, ...
- Industrielle forsknings og udviklingsprojekter
 - Bedre forståelse af materialer og processer
 - Nye materialer, produkter, processer
 - Ofte i sammenhæng med grøn omstilling og andre vigtige samfundsudsordener
 - Delvist betalt af fonde eller skatteydere



produktionsnært
need-to-have
umiddelbar værdi
kendt resultat



ikke produktionsnært
nice-to-have
potentiel stor værdi
ukendt resultat



Identifying foreign objects

Foreign bodies and contaminants are costly to production sites

They may lead to production shut down, project rejections, and recalls of products which all are very costly and mean loss of business.

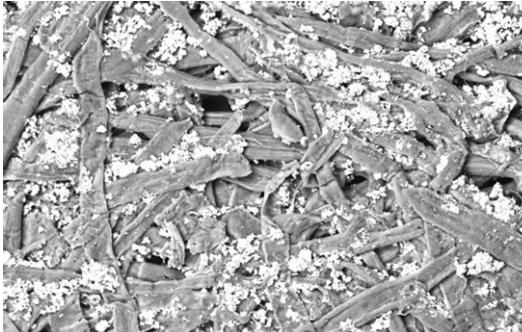
Food and pharma production

Identifying contaminants is crucial to ensure product safety and quality to protect consumers from health risks in both the pharma industry (GMP) and food production (HACCP).

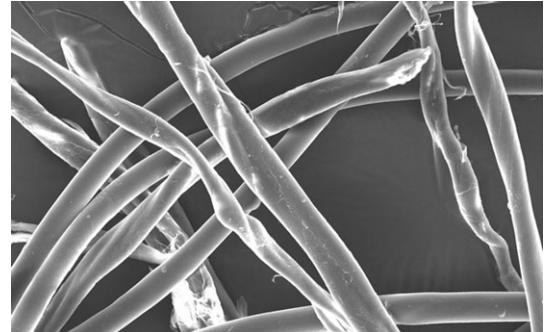
Quick and thorough identification of contaminants

Get particles extracted from production or impurities on surfaces identified to determine the hazard and avoid reoccurrence.

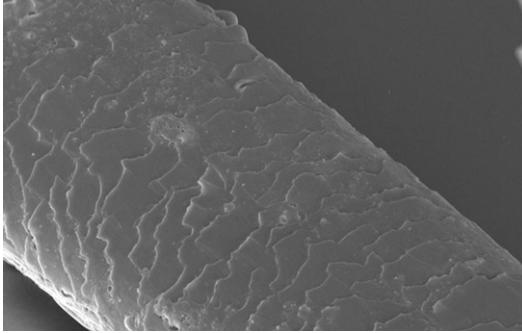
Paper



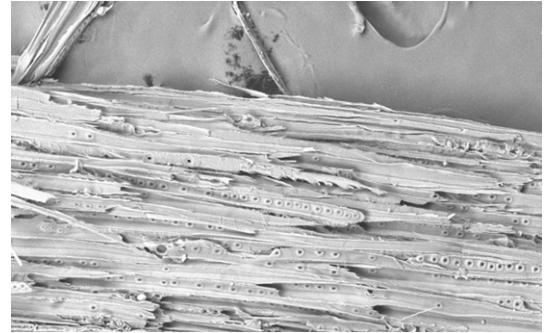
Cotton



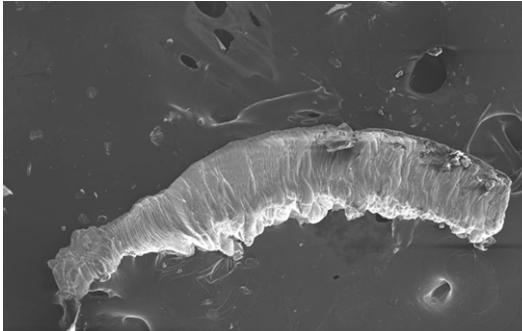
Hair



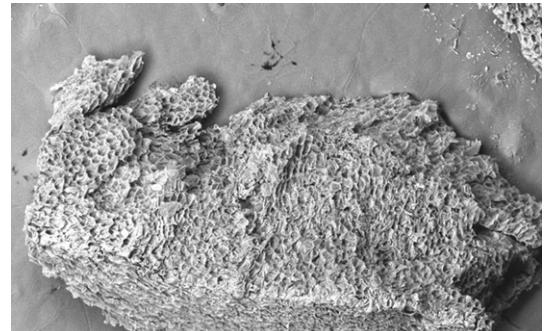
Wood



Steel wear particle



Cork



Vores værktøjskasse

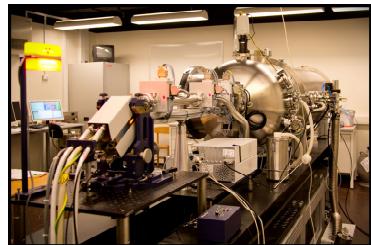
Vores daglige værktøjskasse

- Elektronmikroskopi
- Konfokalmikroskopi
- FTIR-spektroskopi
- Mekaniske tests
- DSC/TGA
- ...

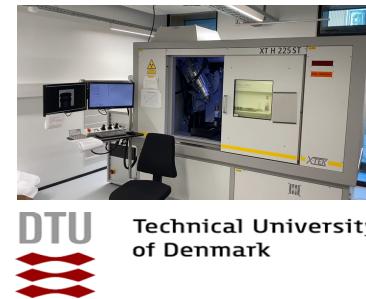


Dagligt

Vores udvidede værktøjskasse



UNIVERSITY OF
COPENHAGEN



Technical University
of Denmark

Månedligt

Den helt store værktøjskasse

synkrotroner



Neutroner (ESS)



Få gange årligt





INDSATSUMRÅDE

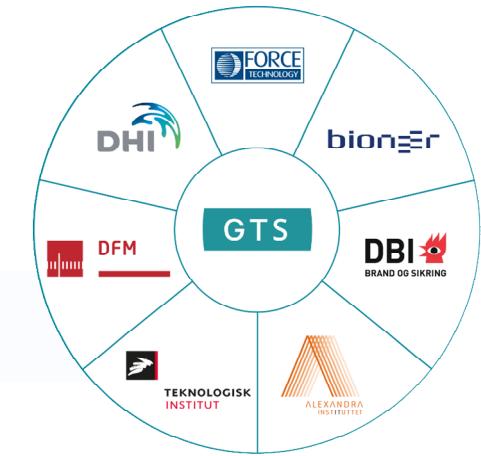
Resultatkontrakt 2025-2028

Avanceret karakterisering af produkter og processer på storskalafaciliteter

Danske virksomheder skal have adgang til neutron- og synkrotronfaciliteter som ESS for at udvikle innovative og bæredygtige produkter. Dette vil styrke deres konkurrenceevne, især inden for energiteknologi, bioteknologi og avancerede materialer, ved at tilbyde dyb indsigt i materialers egenskaber.

Kategorier: Materialeteknologi, Miljøteknologi og cirkulær økonomi,
Produktionsteknologi

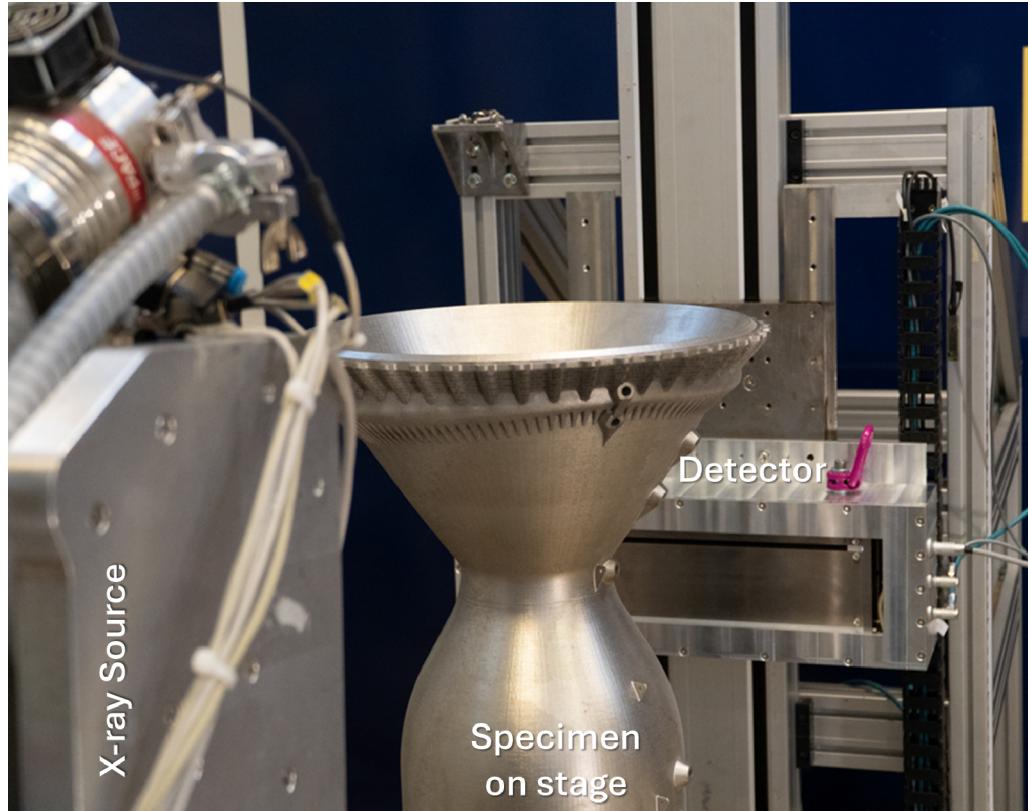
Læs mere på <https://bedreinnovation.dk/>



Eksempler

Kvalitetskontrol af store emner - raketter

X-ray CT ved FORCE Technology



Prototype af Arianne 6 raketdyse



LARGE SCALE 3D PRINT/AM

Quality control of large-scale 3D printed metal components with 3D X-ray CT

Challenge

3D printing/AM provides great design freedom to create revolutionary new designs. The challenge is how to control the quality of the finished items effectively and thoroughly – in this case, a critical component exposed to high mechanical and thermal stress. Standard X-ray CT of metal parts provides insufficient resolution.

Solution

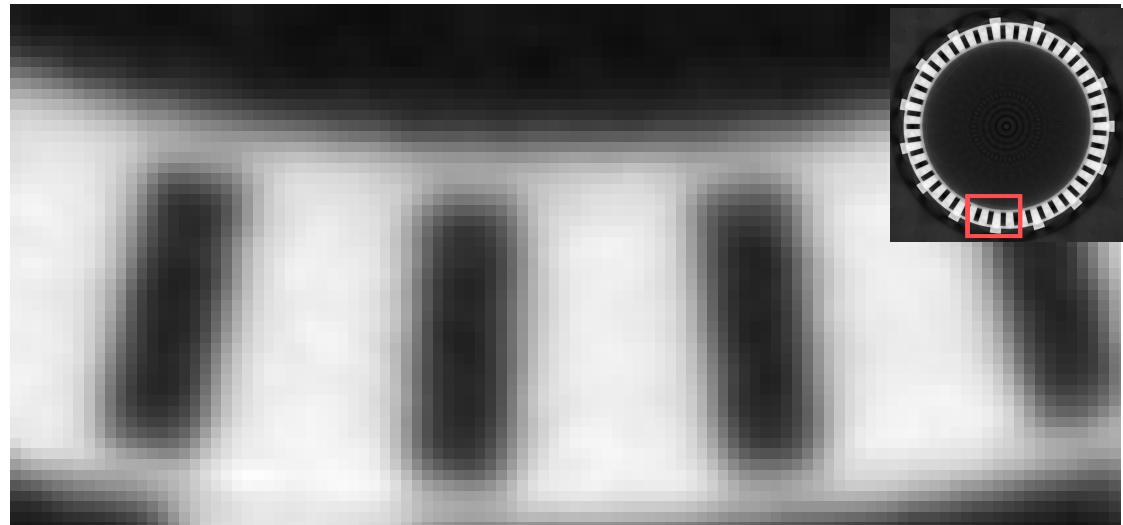
We examined the component at ESRF, a joint European research facility in France that produces X-rays 100 billion times stronger than any laboratory. Synchrotron X-ray CT enables high-resolution images even of large and dense metal parts. We used the new equipment to investigate print quality in two 3D-manufactured Inconel parts with a diameter of up to 80 mm and a resolution of 0.023 mm.

Result

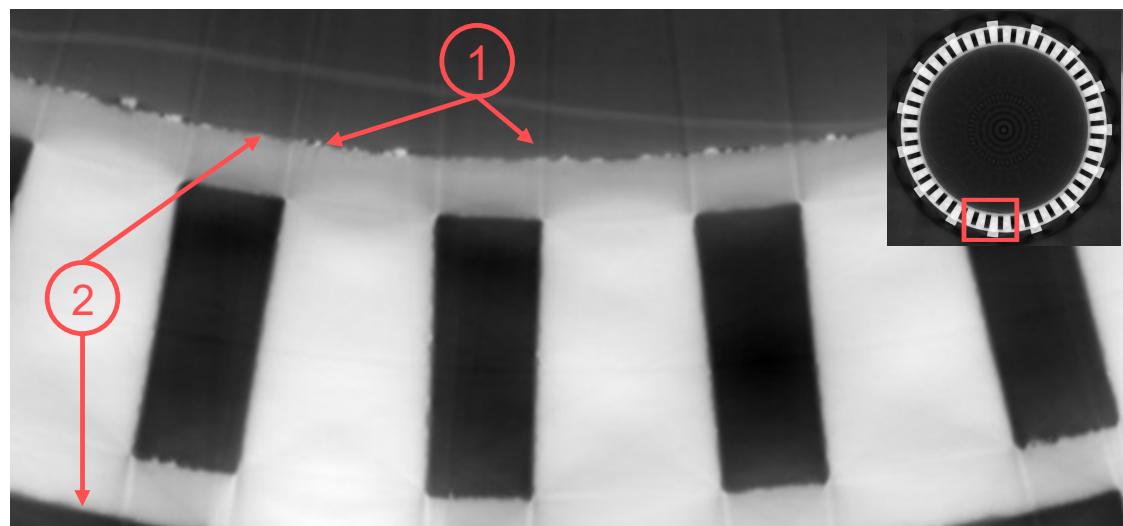
We were able to make ultra-high quality geometric comparisons with the CAD model and we detected:

- Variation in surface roughness and unexpected holes in the 3D print.
- Small channels and corners that have been mistakenly filled in during the printing process and individual particles that sit on otherwise smooth surfaces.

Standard x-ray CT



Synchrotron x-ray CT



CASE – Glysious

Neutron analysis helps develop adhesive patches

Challenge

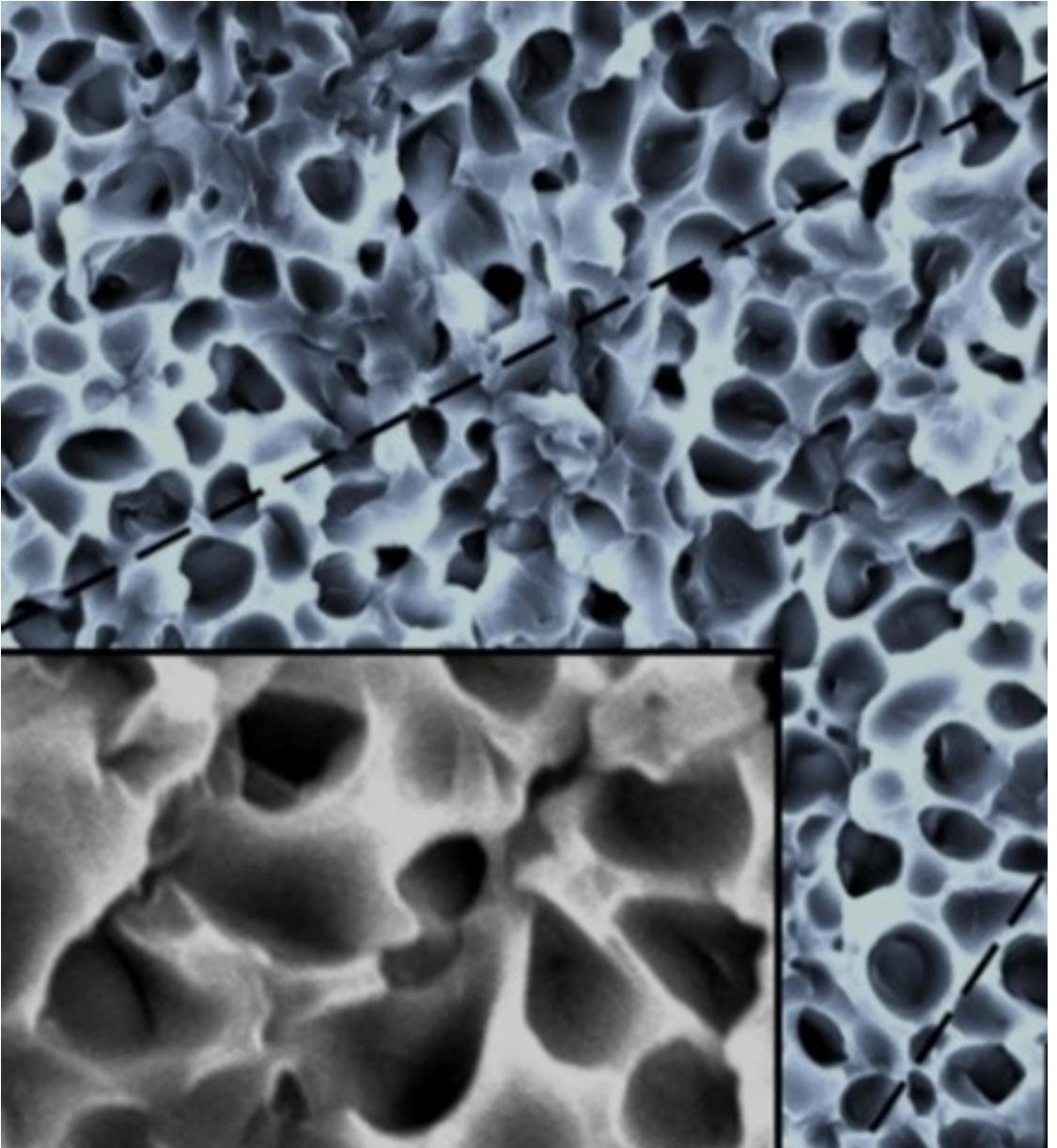
Glysious has developed a technology based on silicone rubber with microscopic glycerol droplets inside that is used for adhesive patches that can release drugs onto the skin. The functionality of the material depends on the distribution of glycerol in the silicone, but how to study the structure?

Solution

We identified neutron analysis as the ideal method to characterise the Glysious material. Neutron experiments were performed in a nuclear reactor at the Technical University of Delft in collaboration with university scientists. We planned the experiments and analysed the data.

Result

Glysious has obtained essential knowledge based on advanced neutron techniques to improve their understanding and design of the Glysious material. They can now optimise the delivery of therapeutic drugs for their adhesive patches in a controlled and targeted way as well as predict long-time stabilities.

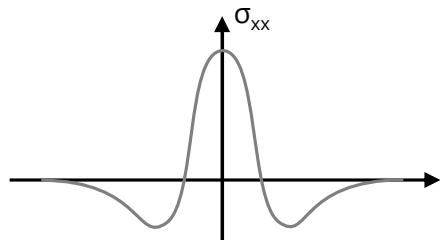
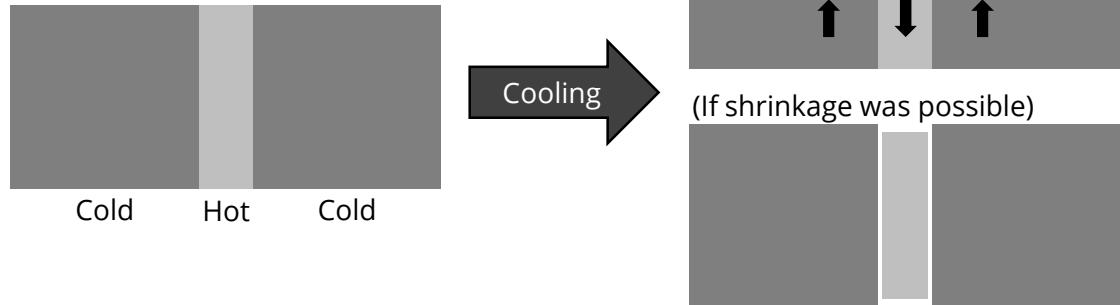


Eksempel fra Teknologisk institut

Restspændinger

RESIDUAL STRESS - BASICS

- Residual stresses occur during manufacturing and application.
 - Temperature gradients =>
 - Shrinkage
 - Mechanical processes
- Example: welding of two plates

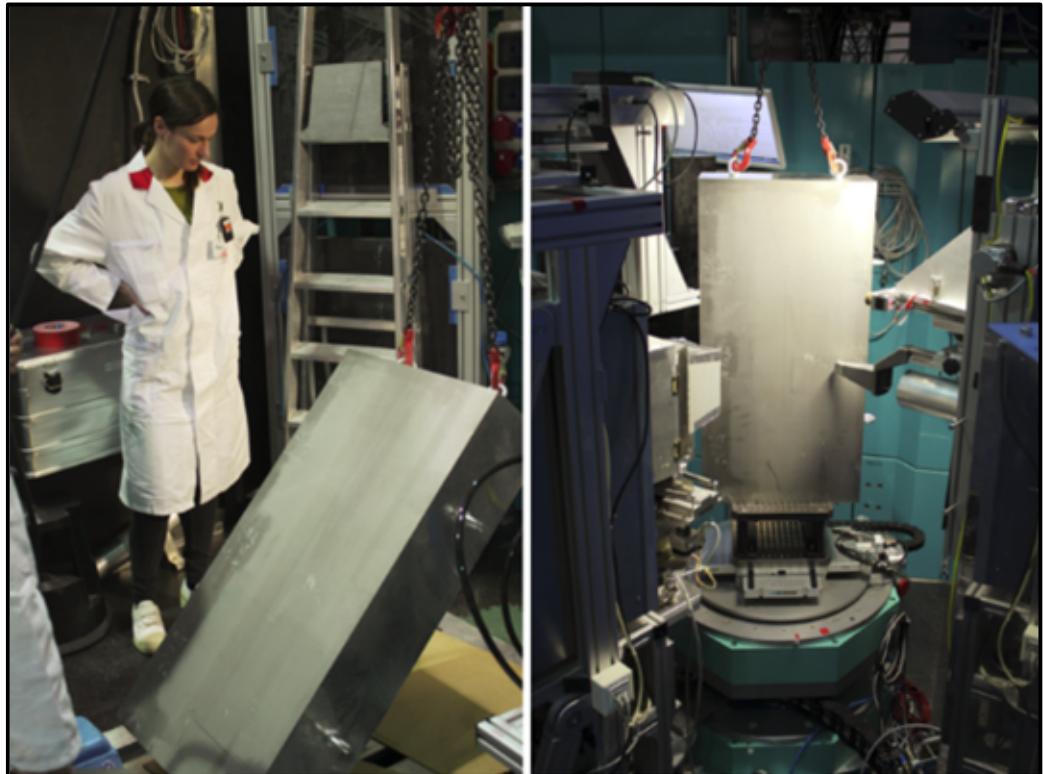


INDUSTRIAL RELEVANCE OF RESIDUAL STRESSES

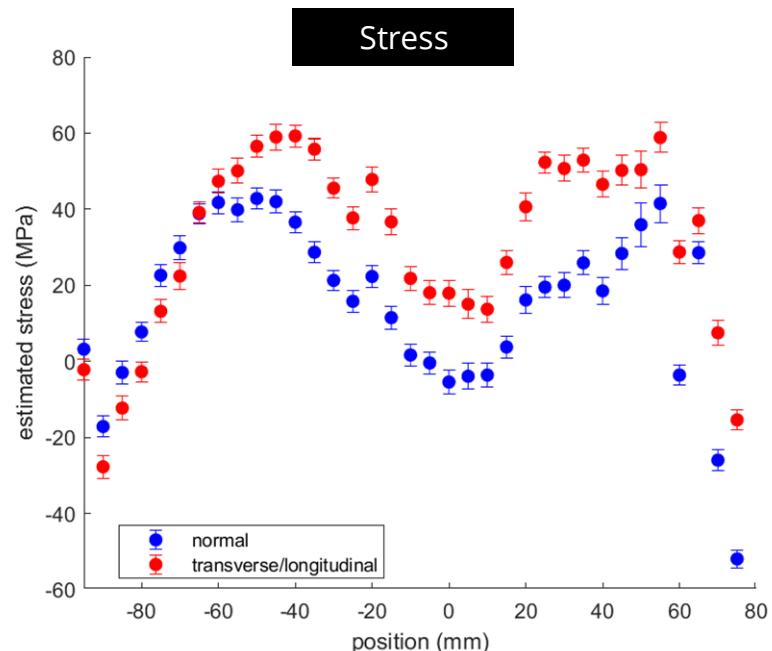
- Increased product lifetime from the inhibition of fatigue crack initiation and propagation.
- Reduced risk of critical failure.
- Reduced risk of stress corrosion cracking.
- Decreased development time.
- Reduced amount of scrapped parts.



CASE STUDY - ALUMECO



During processing, there is a risk that the processed material may distort due to the residual stresses in the material. These are normally removed by heat treatment, but it is not possible for special types of aluminum used in, e.g., the aerospace industry. Quality assurance through measurement of the residual stress level can provide a competitive advantage in the global aerospace market as a supplier of 'stress-free' aluminum.



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COMING SOON...

3D printing in orbit

- In collaboration with DTU Space and ESA, the first Danish astronaut on the ISS installed the first metal 3D printer in space.
- DTI will utilize neutron diffraction to investigate the residual stress relative to a terrestrial sample, non-destructively.
- The cooling rate and thereby the stress is different when printing without gravity. Residual stress influences the dimensional stability and performance!
- **Outlook:** Mastering metal 3D print in space is a requirement for long manned missions and large construction in space, e.g. solar satellites.



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Konklusion

- Jeg synes potentialet for at anvende neutroner og synkrotroner med vores kunder er stort, og jeg er sikker på, at der kommer nogle spændende F&U projekter ud af det.
- Med tiden tror jeg også vi kommer til at se flere kommersielle anvendelser til nogle af de mere produktionsnære problemstillinger. Det kræver lettere adgang til analyser, der er mere standardiserede.
- Jeg glæder mig til at kunne udføre de første eksperimenter på ESS!



Spørgsmål



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