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# Technological infrastructure as enabler for innovation and uptake of new technology in SME's

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# Danish Technological Institute



# Creating value since 1906

For more than a century the Danish Technological Institute has been involved in the technological evolution, making it one of the oldest of its kind in the world.



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“ We believe that technology has the power to improve business, society and people’s lives.

Independent and not-for-profit



# Technological infrastructure

- More than 1.000 specialists
- State of the art-equipment and facilities
- 80+ laboratories





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More than 12.000 customers  
in 67 countries



# A key driver in R&D

- Bridging the gap between research and practical application
- Since 2011, we have participated in 2,000 projects with 5,500 partners

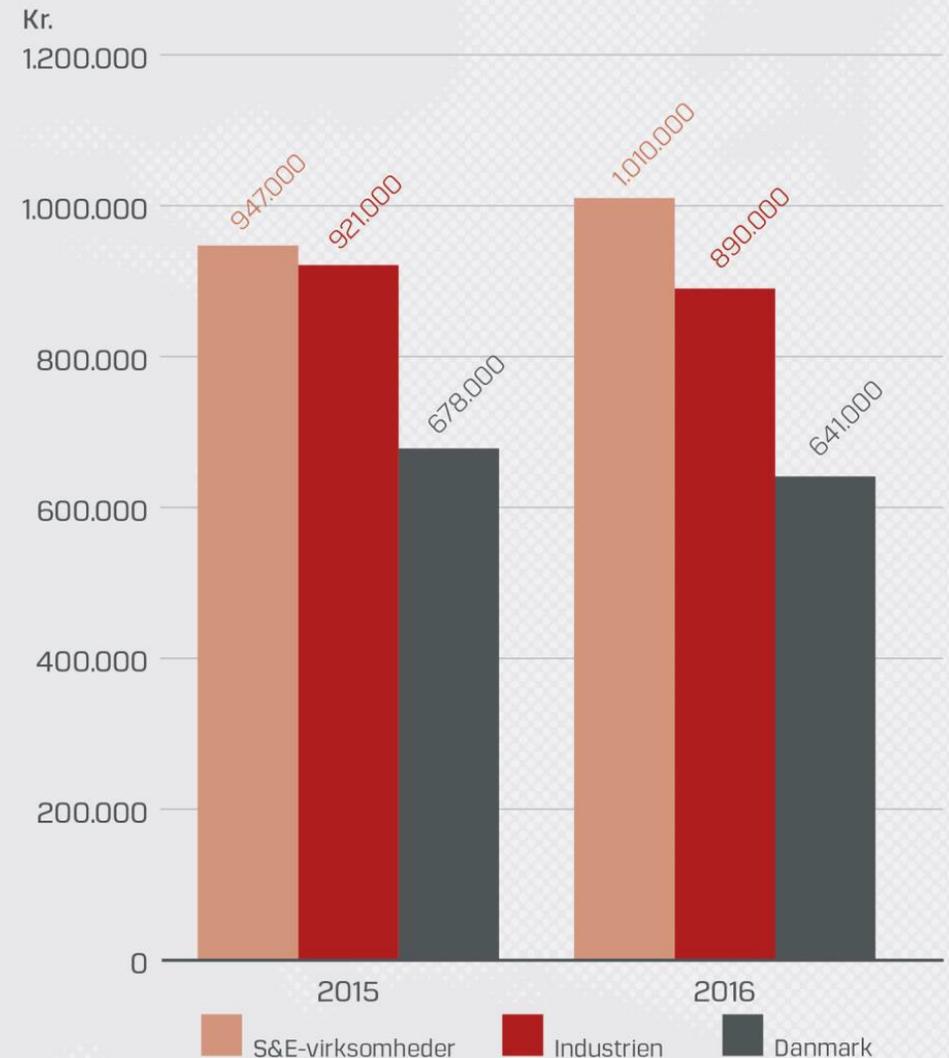


# S&E companies and startups

- They grow much faster, have higher productivity, export earlier and hire more employees
- S & E companies exported for 589 billion DKK in 2016 corresponding to 53% of Danish export

## S&E-produktiviteten stiger

Produktiviteten for hhv. S&E-virksomheder, industrien og Danmark, 2015 og 2016, kr.





# Technology is evolving faster than ever

- Shorter product life cycles
- Increased complexity
- Access to the right skills
- Financial risk
- Need for new types of facilities for testing, demonstration and development



## Technology infrastructures

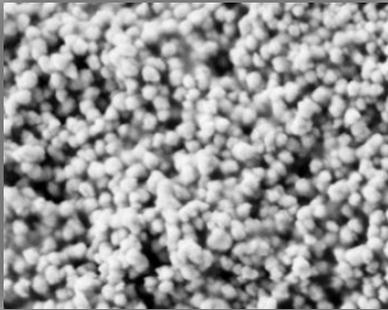
- Minimise costs and lower technological risks
- Tap into relevant competences and services
- Access business services such as mentoring and market analysis



# The DTI Printed Electronics activities



**Fundamental studies**



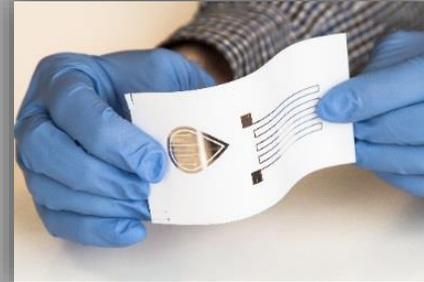
**Digitalized NP production**



**Ink Formulation**



**Digital Manufacturing**



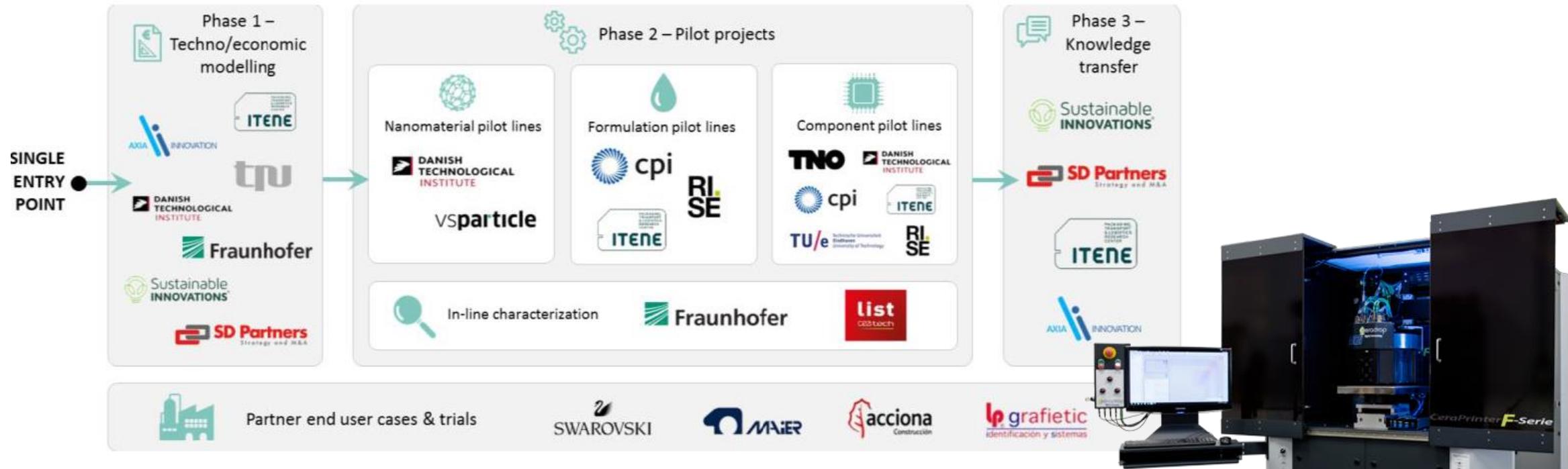
**Applications**

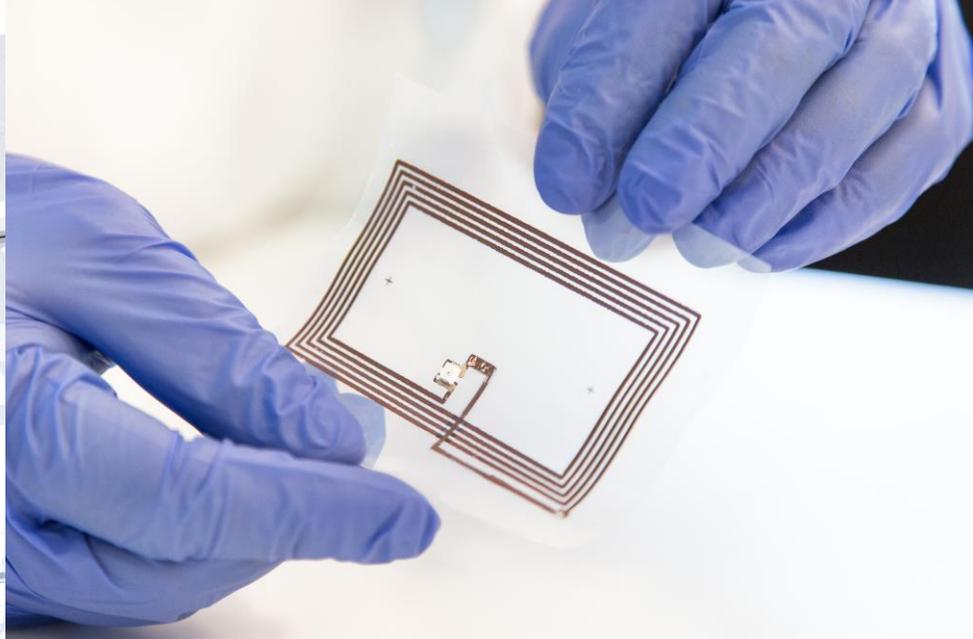


# LEE-BED



Innovation Test Bed for development and production of nanomaterials for lightweight embedded electronics

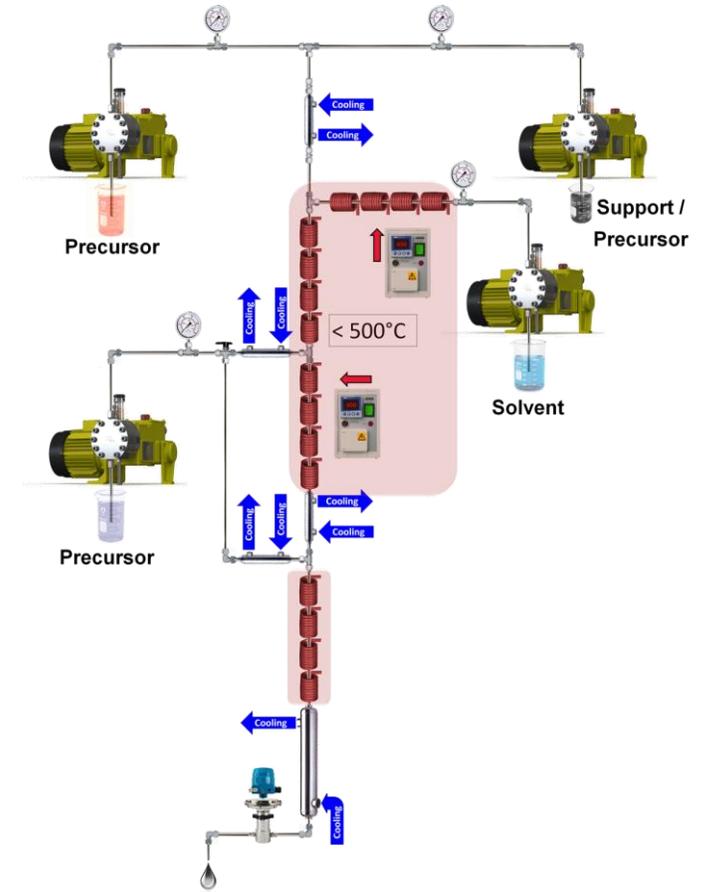






## Continuous flow nanoparticle synthesis (both supercritical & sub-critical)

- Continuous synthesis
  - Up-scalable
    - Lab experiments (0.1 g/h)
    - High volume production (0.5 kg/h)
  - One-step synthesis
- High control of particle size, uniformity and spatial distribution
- Complex structures possible
  - Pure metals and alloys
  - Oxides
  - Synthesis on support
  - Core-shell structures





# DTI supercritical flow synthesis facilities



Manual lab-scale reactor



Semi-automated reactor



Production-ready automated reactor



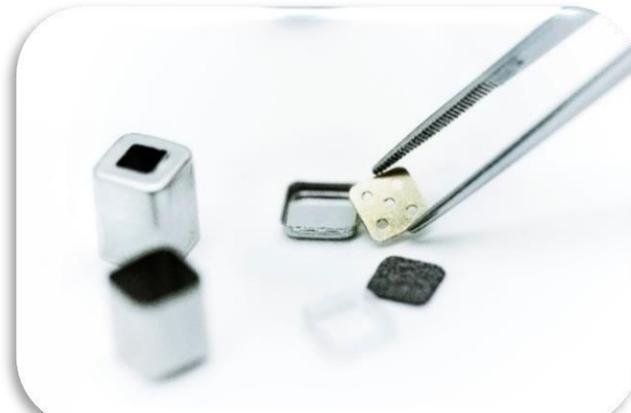
# Nano Catalyst Materials

## Fuel Cell Catalysts

- Pt-based catalyst on carbon support
- Carbon supports
  - Carbon black, carbon nanotubes, graphene
- Two-metal catalyst / core-shell structures on support
  - PtRu on carbon
  - PtPd on carbon
  - PtNi<sub>x</sub> on carbon
- Three-metal anode catalyst
  - PtRuMo
  - PtRuNi

## Diesel Filter Catalysts

- Catalyst on oxide support
  - Platinum
  - Palladium
  - Rhodium
- Support materials
  - Gamma Alumina
  - Ceria Zirconia

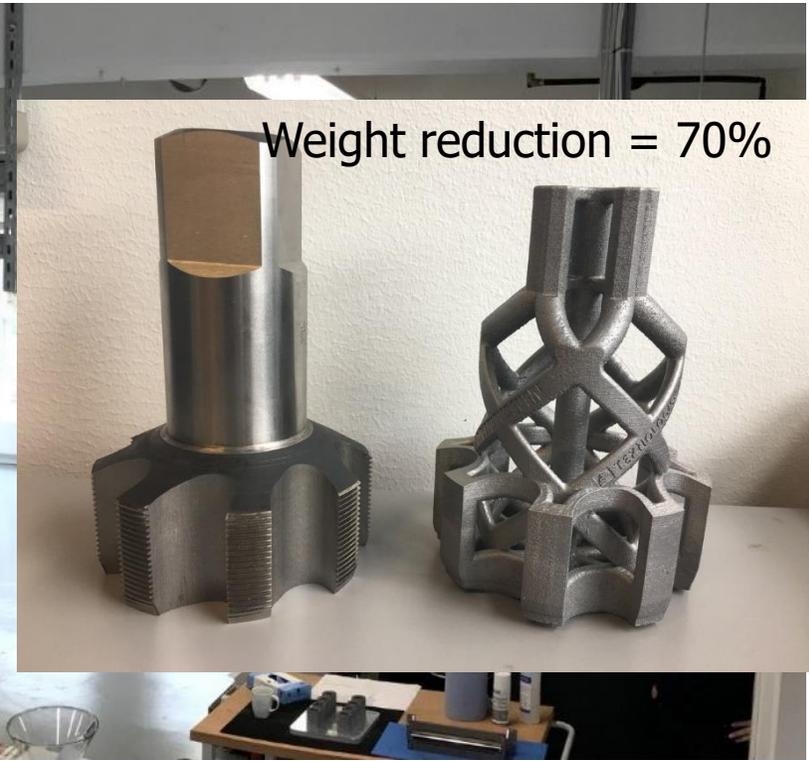




# Additive Manufacturing @ DTI

## Industrial production without geometrical limitations

- Complex designs
- Short lead time
- Flexible production

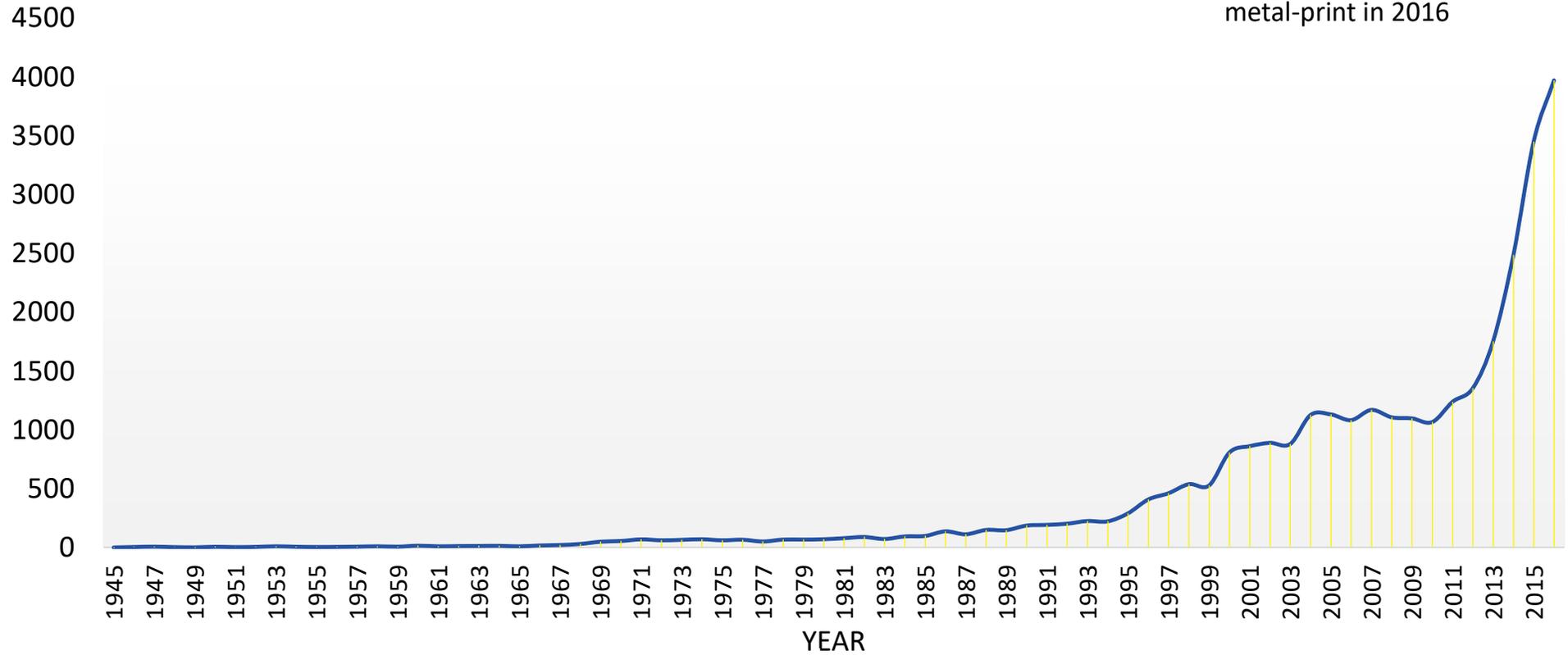




## Patents on metal 3D printing (globally per year)

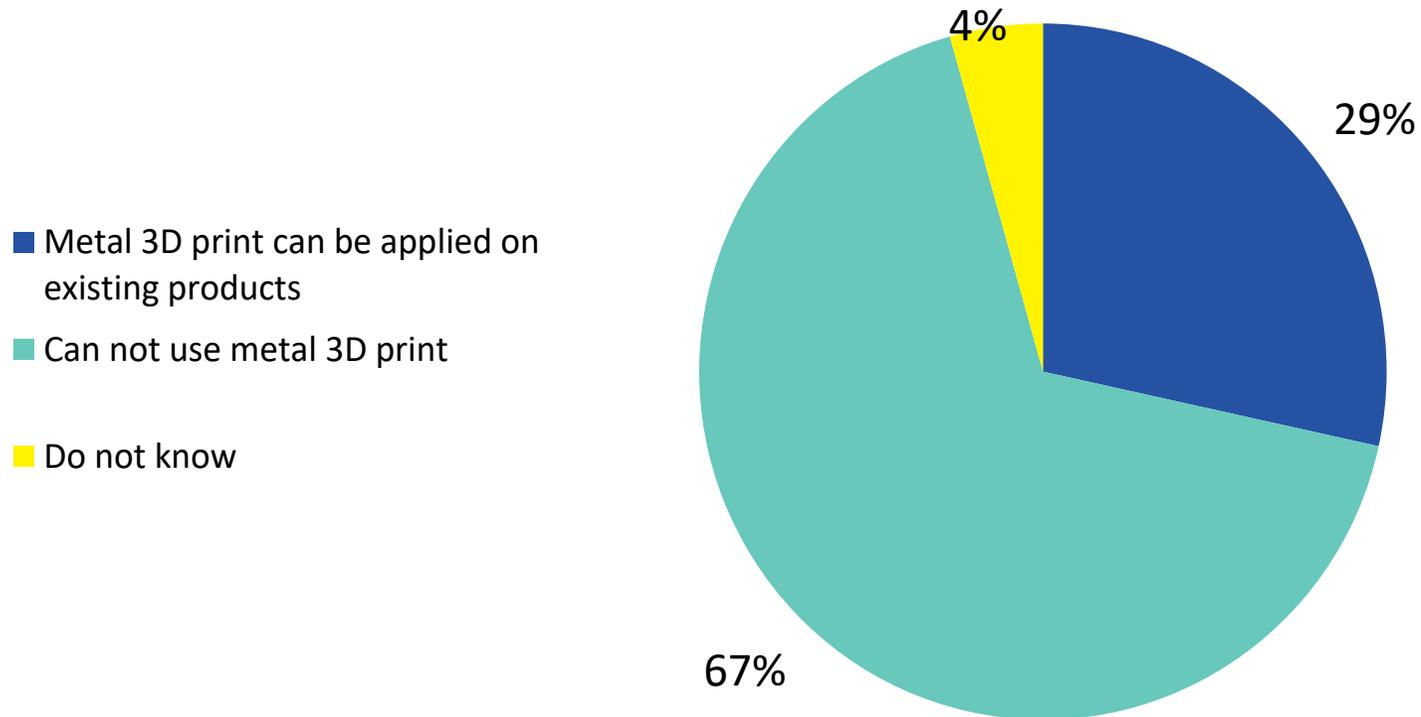
3.971 patent applications on 3D  
metal-print in 2016

NUMBER OF PATENT





## Companies with products that can be fully or partially 3D printed in metal

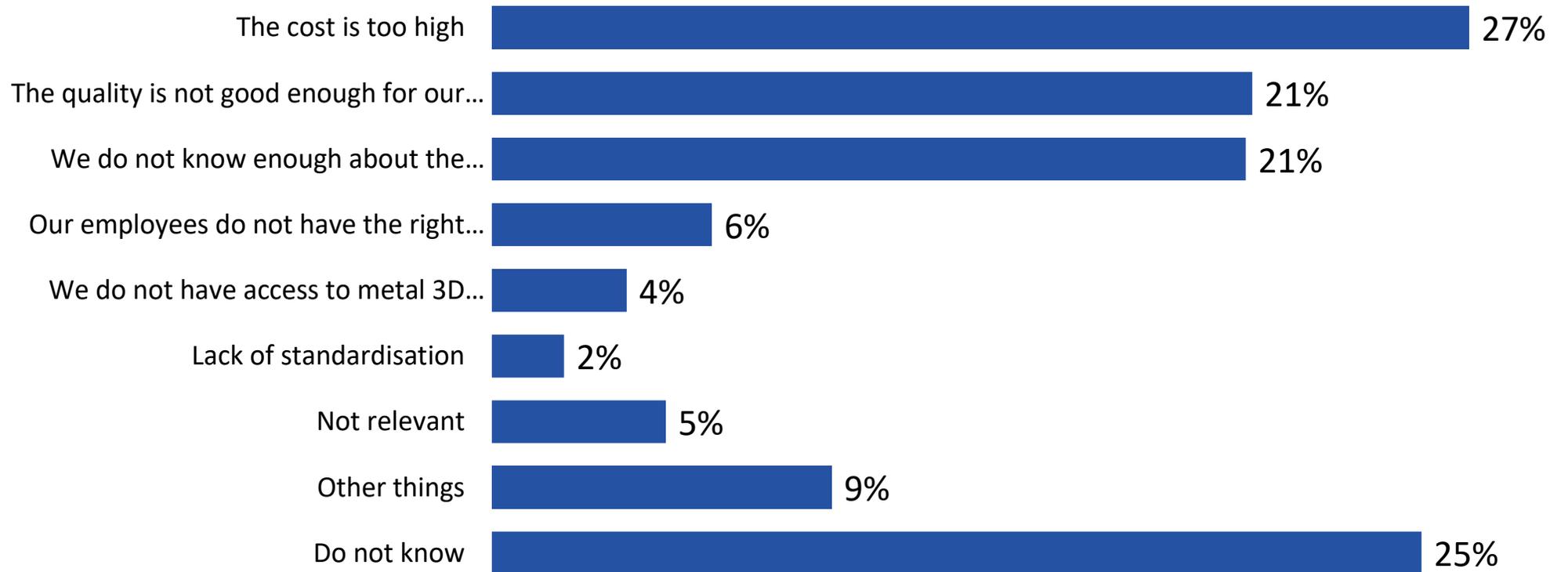


Note: Interview with Danish production companies. 526 responses. Question: Abroad, car and medico industry are using 3D printing in metal. 3D printing can be used to produce metal parts in all industrial alloys. We would like to hear your thoughts on this. Do you manufacture products that can be fully or partially printed in metal 3D printing?



## Barriers for metal 3D printing

Responses from companies that find 3D metal print relevant



Note: Interview with Danish manufacturing companies. 134 responses. Responses from companies that find 3D metal prints relevant, but do not use 3D metal prints today.

Question: Where do you see the biggest barriers to introducing 3D printing of metals as part of your business?



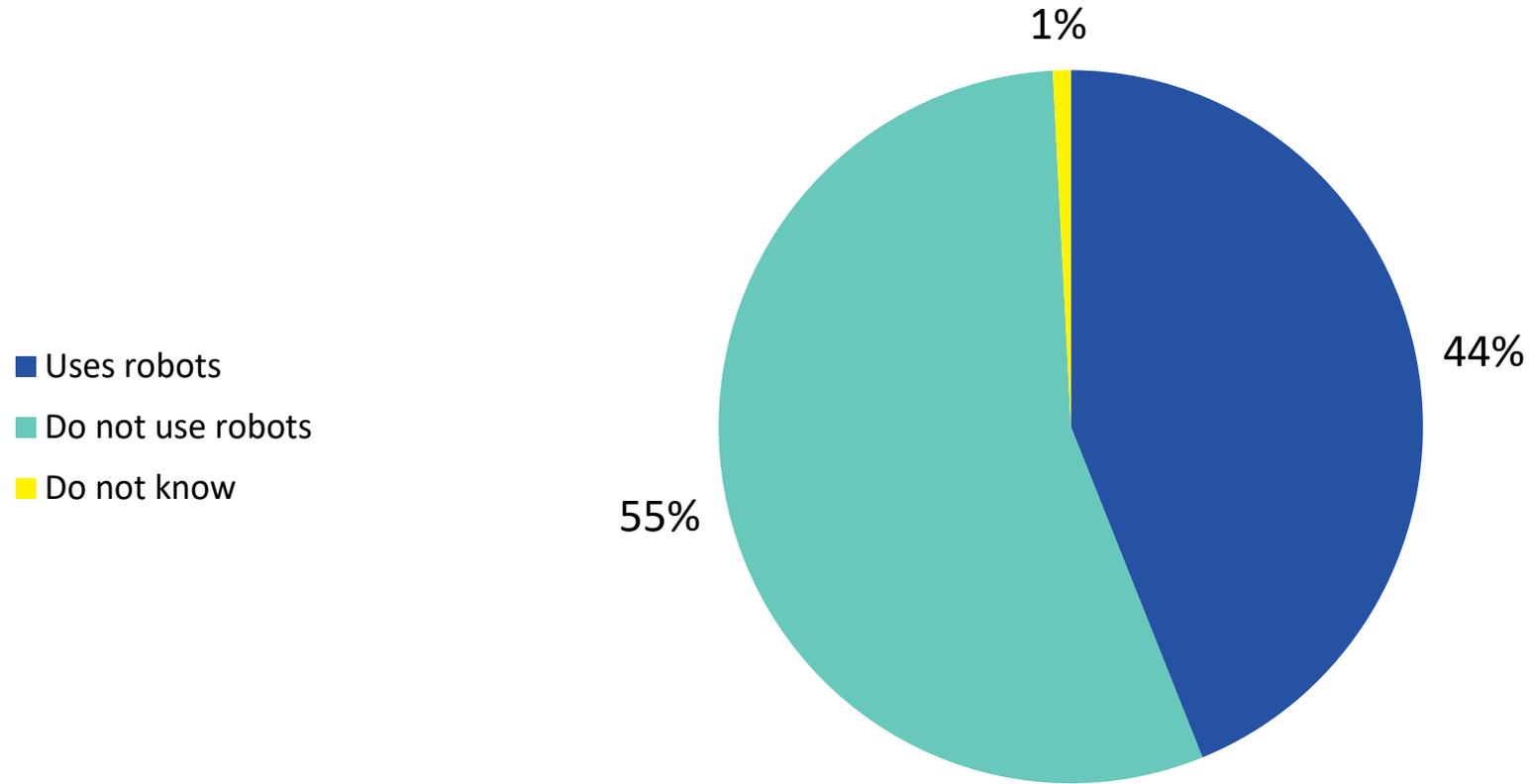
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COLLECTING THE  
KEY TO MANAGE  
OUR NEW  
GENETICS  
TECHNOLOGIES



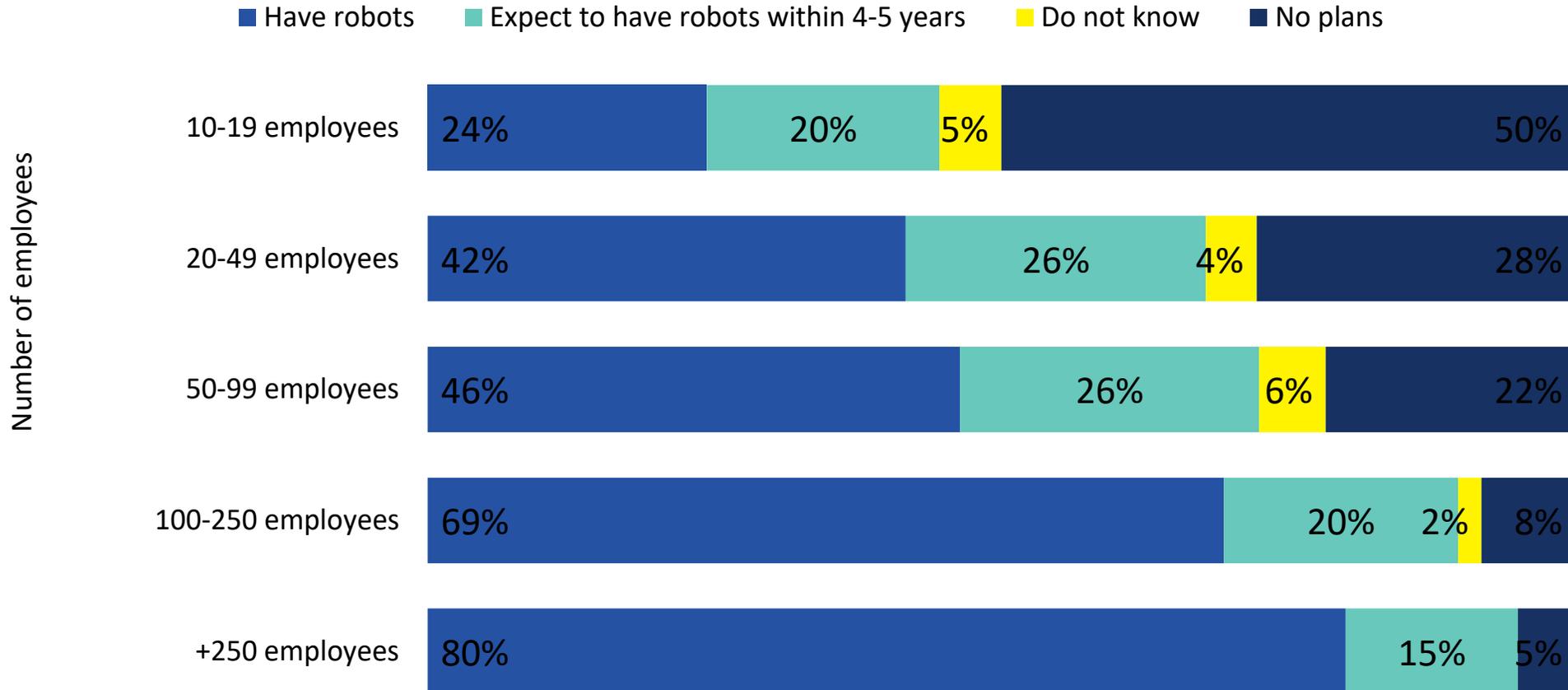
## Share of companies that use robots in production



Source: Danish Technological Institute. Interview with Danish manufacturing companies. 526 responses.  
Question: Does the company use robots in production?



## Expectations of robots in production - broken down by company size



Source: Danish Technological Institute. Interview with Danish manufacturing companies. 526 responses.

Question: Will it be possible for the company to introduce robots within the next 4-5 years? Does the company use robots in production?



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HEALTH CARE



AgroFood



SAFETY



MANUFACTURING



INSPECTION &  
MAINTENANCE



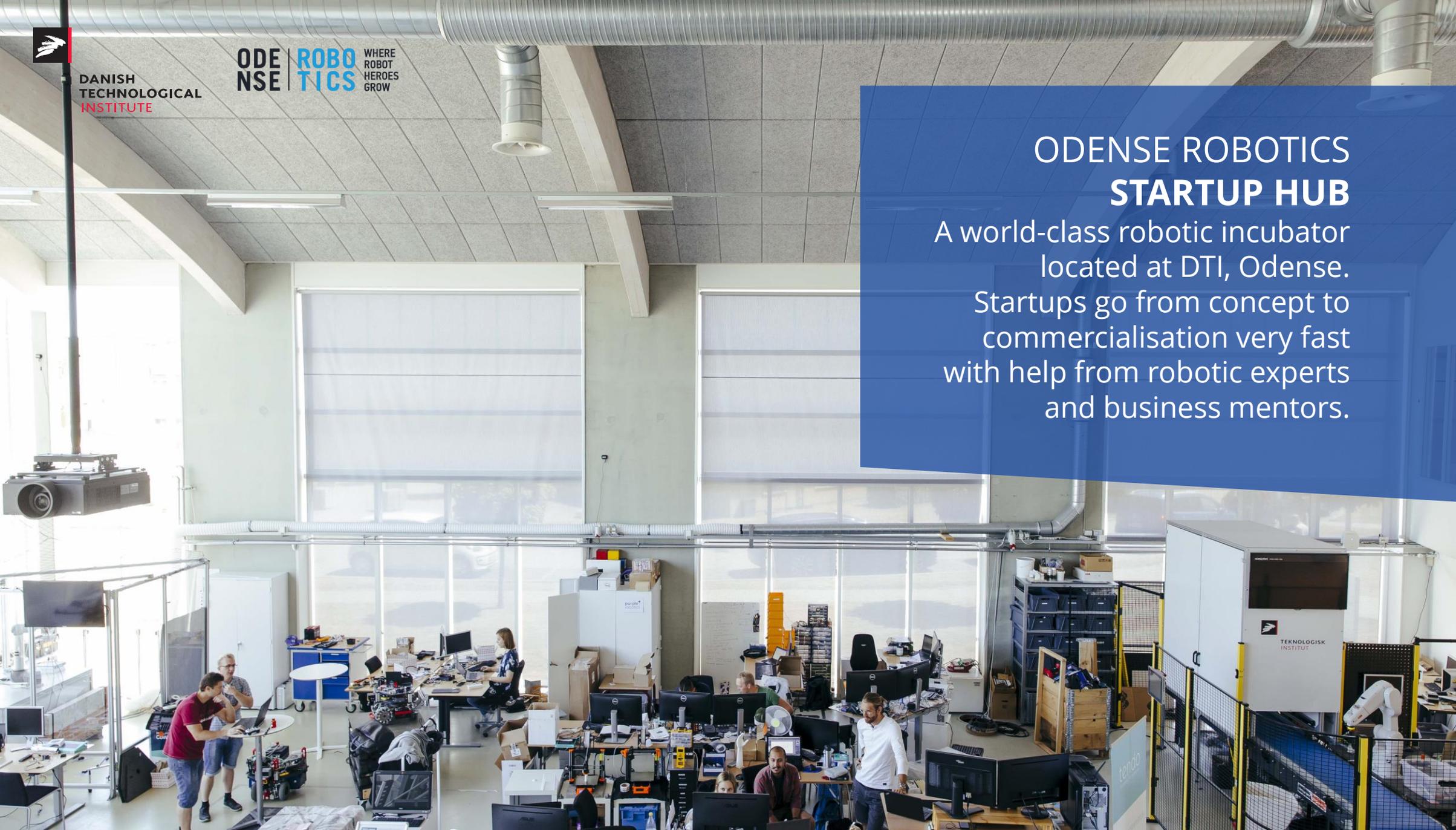


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ODENSE  
ROBOTICS  
WHERE  
ROBOT  
HEROES  
GROW

# ODENSE ROBOTICS STARTUP HUB

A world-class robotic incubator located at DTI, Odense. Startups go from concept to commercialisation very fast with help from robotic experts and business mentors.



# FOULING REPELLENT SOL-GEL COATINGS

DTI have specialized in the development, test, production and application of functionalized Sol-Gel coatings for demanding applications



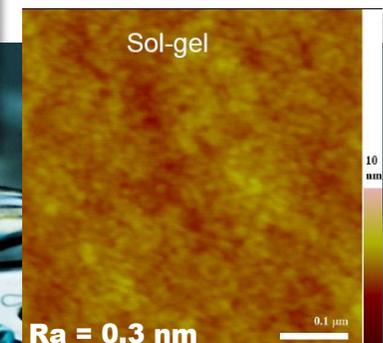
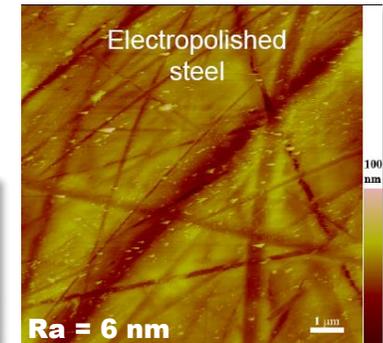
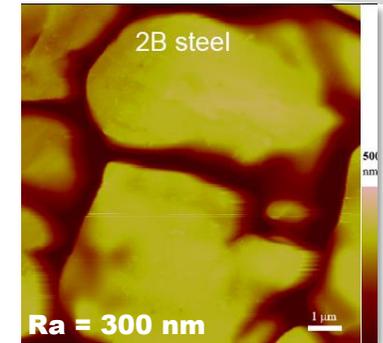
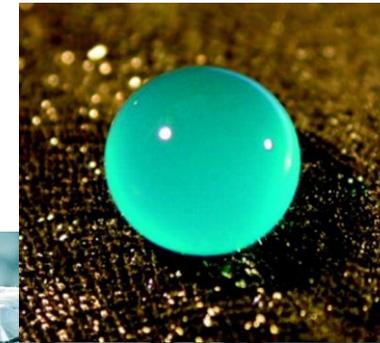
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## Characteristics:

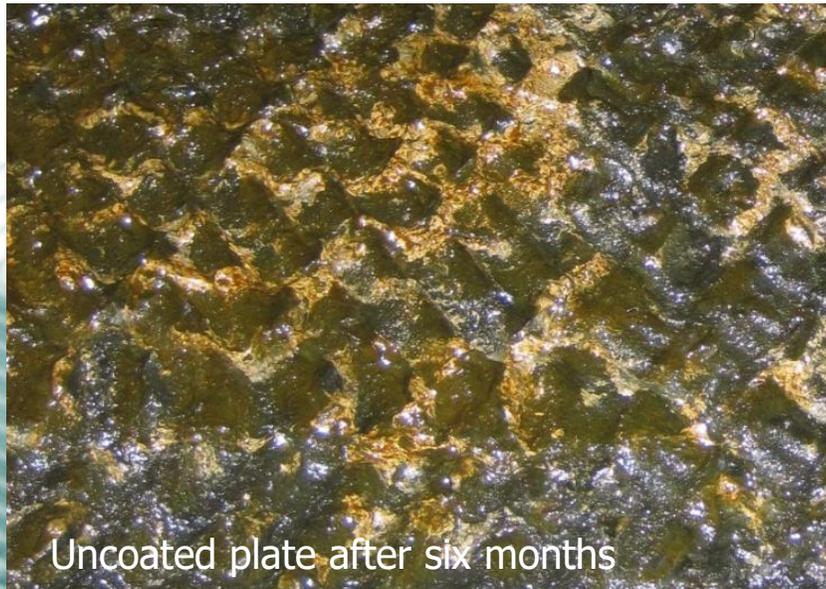
- Sol-Gel coatings
  - Nano Functional Repellent Surface
  - Thin and heat conductive
  - Flexible and robust – even in harsh off-shore environments
  - Liquid coating, applied by spray, cured at low temperature
- 
- Low surface energy
  - Smooth
  - Inert
- } Provides repellent functionality





## Plate Heat Exchangers for Crude Oil Cooling

- An uncoated Heat Exchanger may require on-shore refurbishment after six months of service
- A coated Heat Exchanger can be operated for more than three years without service





## Fouling Prevention of Centrifuges

- Centrifuges for cleaning of produced water require “Cleaning In Place” with hydrochloric acid
- An uncoated Centrifuge may require CIP’ing on a daily basis
- A coated centrifuge can be operated for more than a year without CIP’ing





## Off-Shore Fouling Prevention: Value Proposition

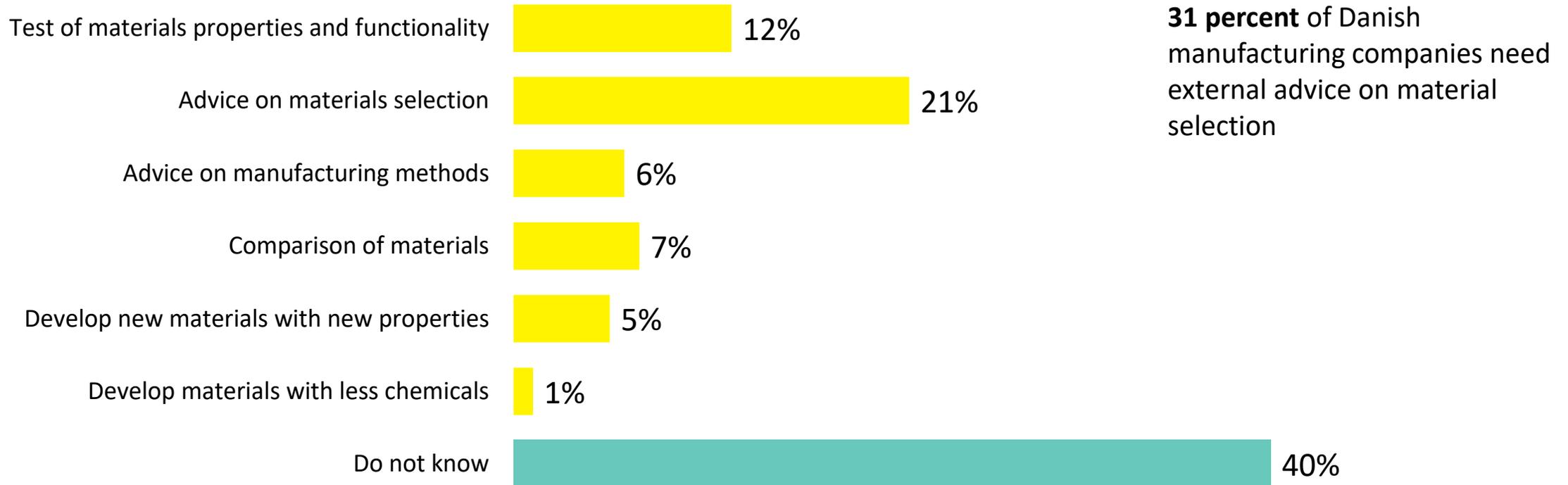
The use of fouling preventing Sol-Gel systems on crude oil processing equipment ensures:

- Extended operation
- Increased reliability
- Direct cost savings
- Reduced production down-time
- Reduced personnel costs
- Lower energy consumption
- Reduced logistics





## Types of external consulting that are demanded by the companies



Note: Interview with Danish manufacturing companies. 526 responses. More answers possible. Another 12 percent responded "Other" and pointed out in particular the need for advice from customers or suppliers.

Question: What types of external advice on material selection do you expect you to need in the coming years?

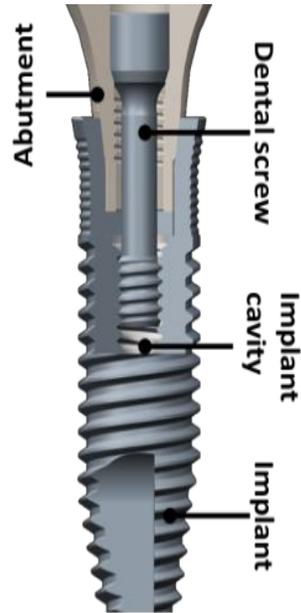


# Coatings for medical applications based on Physical Vapor Deposition (PVD)

- Case 1: Low-friction coatings for dental applications
- Case 2: Sr-Ti coating for accelerated bone growth



# Important to tighten dental implants

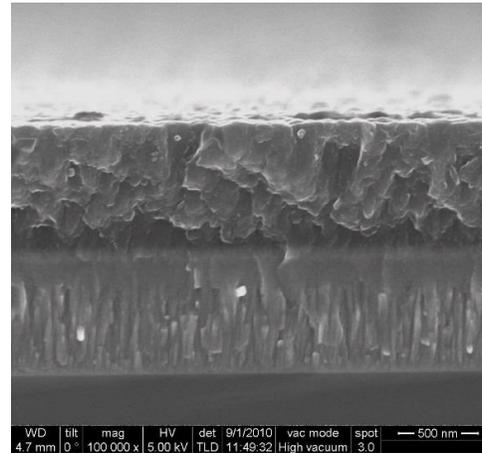


## Coatings

a-C toplayer

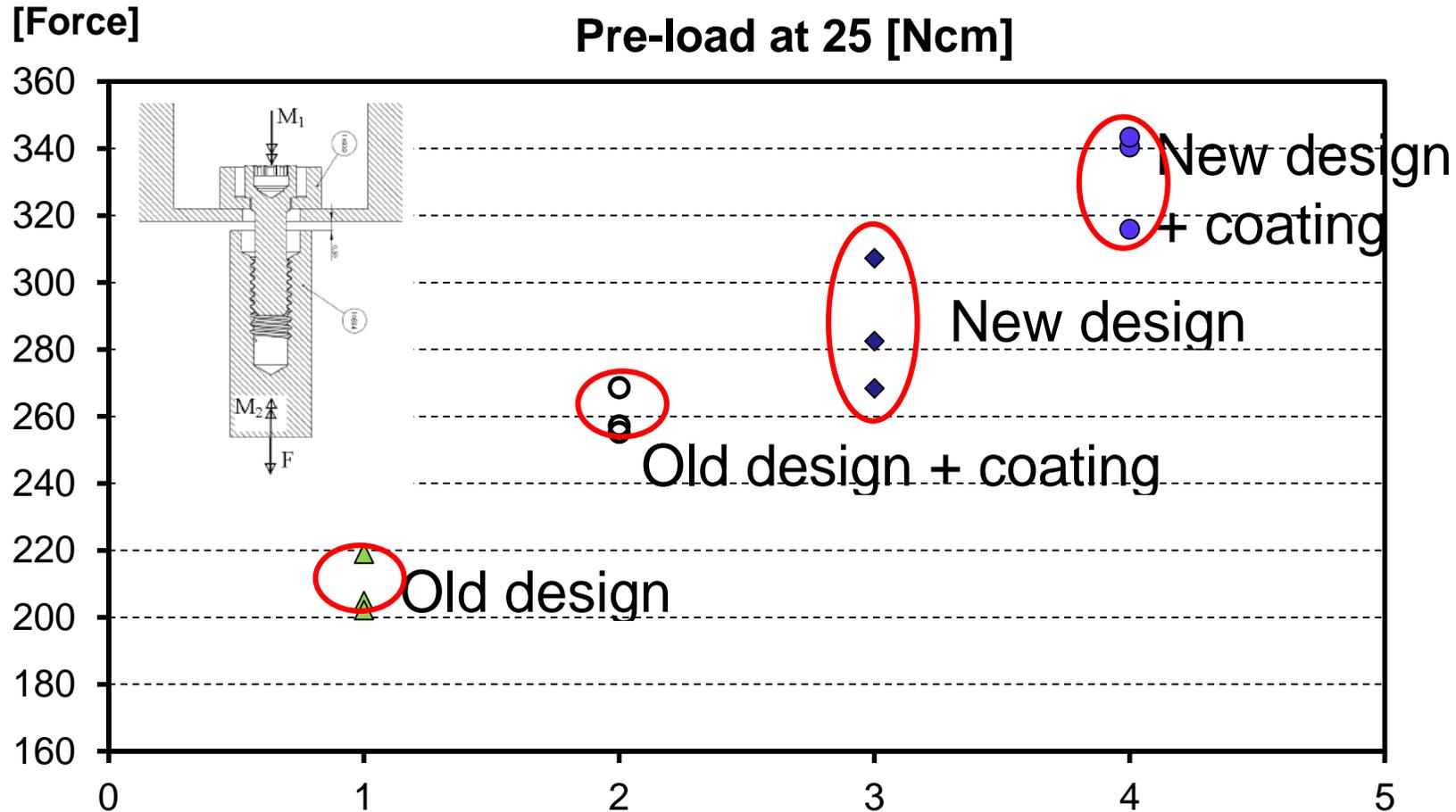
CrN adhesion

Titanium substrate





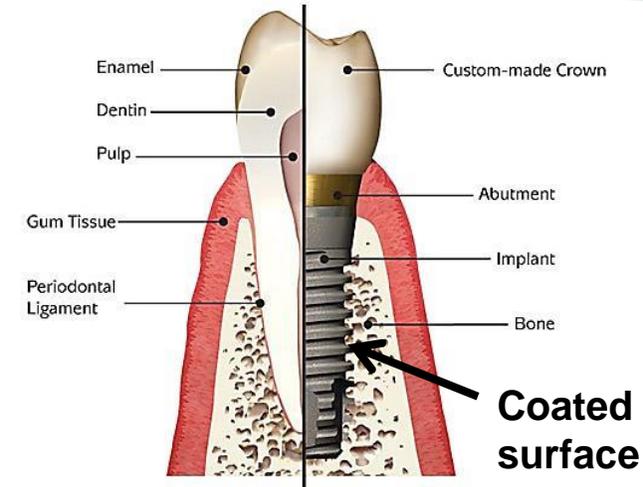
# Tightening force – fixed momentum





# Why Sr?

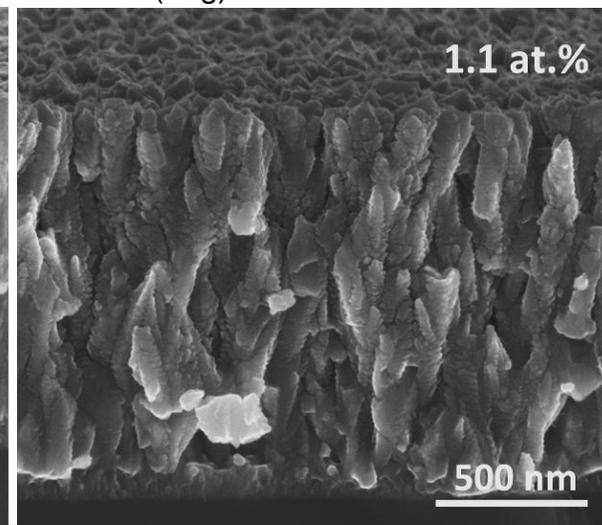
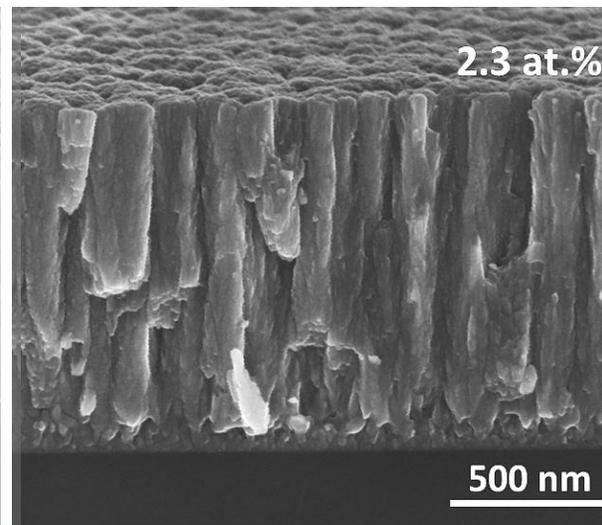
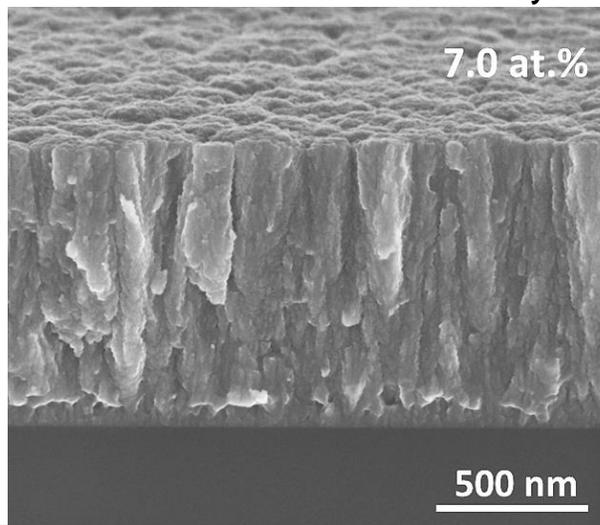
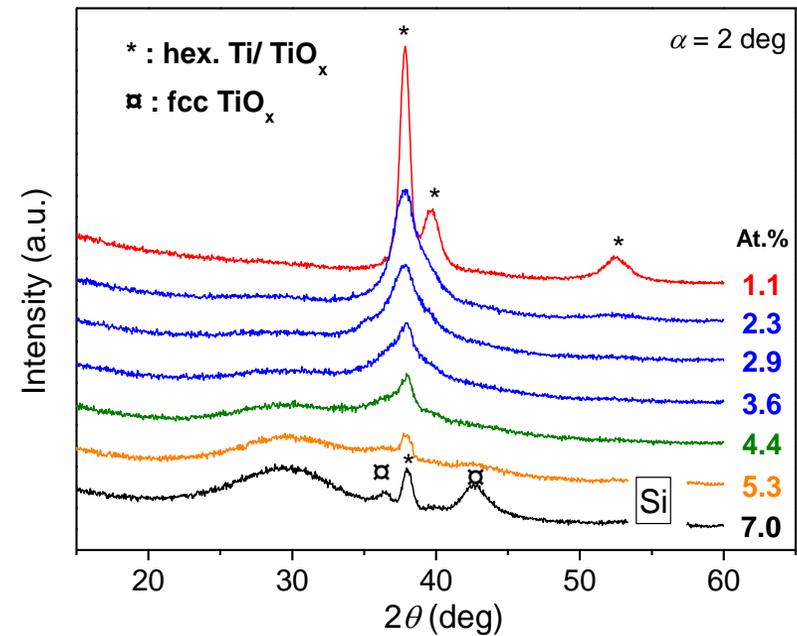
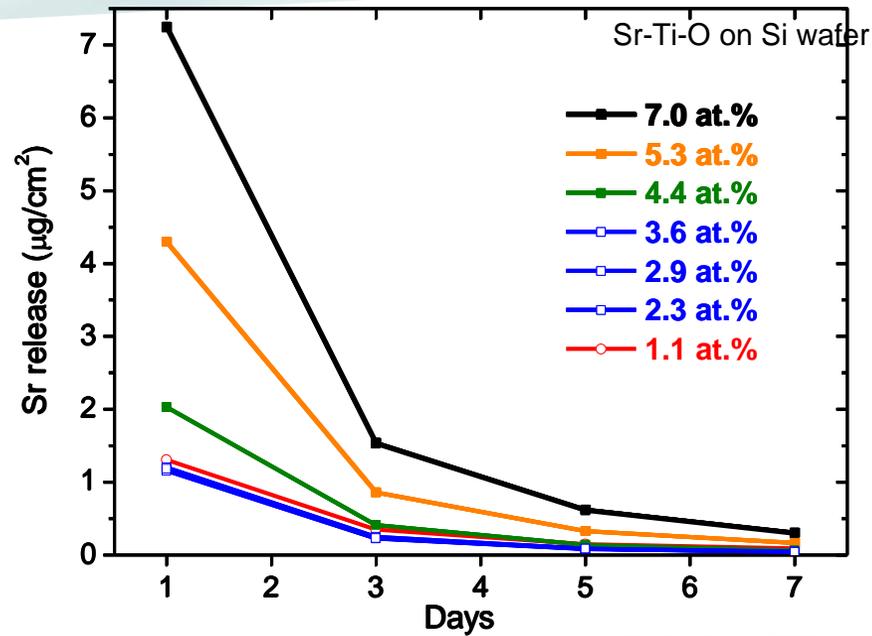
- Substitutes for Ca in mineral phase of bone
- Stimulates bone formation
- Reduces bone resorption
- Shown anti-inflammatory effect
- Sr is used via strontium ranelate as treatment for osteoporosis
- Sr in the surface of an implant gives local effect where needed



Na Sodium 22.98976928	Mg Magnesium 24.3050
19 K Potassium 39.0983	20 Ca Calcium 40.078
38 Sr Strontium 87.62	

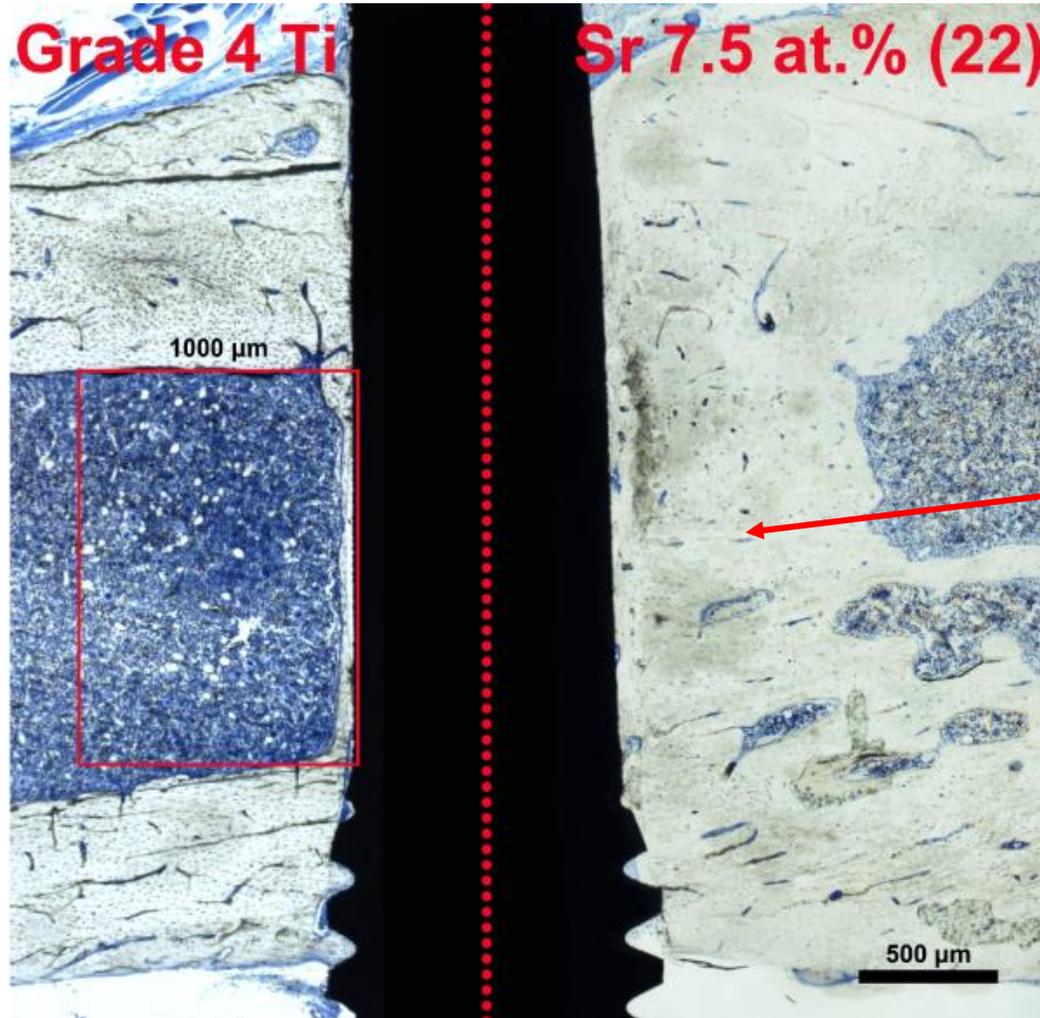


# Sr release vs. Sr concentration





# Coated implant versus uncoated



Huge amount of  
bone formation



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# Thank you!

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