Business from technology

Nanomaterials and Nanotechnology at VTT

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VTT
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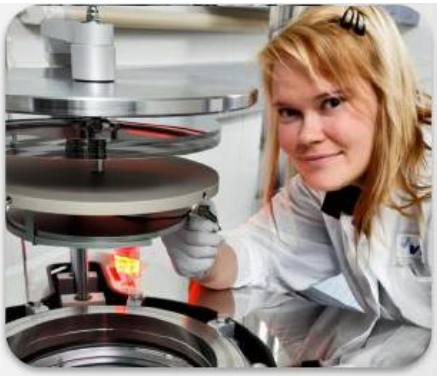
VTT Technical Research Center of Finland (Valtion Teknillinen Tutkimuskeskus)

- **Founded in 1942**
- **VTT in 2011 is the largest multi-disciplinary applied research organization in Northern Europe**
- **Personnel 3167**
- **Turnover 292 M€ (2010)**



Customer sectors
- Biotechnology, pharmaceutical and food industries
- Electronics
- Energy
- ICT
- Real estate and construction
- Machines and vehicles
- Services and logistics
- Forest industry
- Process industry and environment

Focus areas of research
- Applied materials
- Bio- and chemical processes
- Energy
- Information and communication technologies
- Industrial systems management
- Microtechnologies and electronics
- Services and the built environment
- Business research

VTT's operations
- Research and Development
- Strategic Research
- Business Solutions
- IP Business
- Group Services

VTT's companies
- VTT Expert Services Ltd (incl. Labtium Ltd, Enas Ltd)
- VTT Ventures Ltd
- VTT International Ltd
- VTT Memsfab Ltd

VTT's strategic research portfolio

Addressing innovations, business, services and people

Materials for breakthroughs
- functional materials and nanotechnology
- bio-based chemicals and precursors
- industrial biomaterials
- wood-fibre value chain

Enabling electronics and photonics
- high-performance microsystems
- printed intelligence
- sensing solutions

Low carbon technologies in energy
- efficient use of energy
- renewable energy sources
- nuclear energy, clean fossil energy
- energy systems, modelling for changes

Eco-efficient intelligent built environment
- integrated design, production and use
- connected sustainable districts
- multimodal intelligent transport
- comfort, health, safety and accessibility

Emancipation of data
- digital ubiquitous services
- cognitive communications systems, interoperability
- cloudy internet
- green ICT

Industrial resource efficiency
- industrial biotechnology - green chemistry
- clean water, waste refinery
- resource efficient processes

Technologies for health and wellbeing
- healthier food solutions
- drug discovery
- molecular diagnostics
- ICT for health

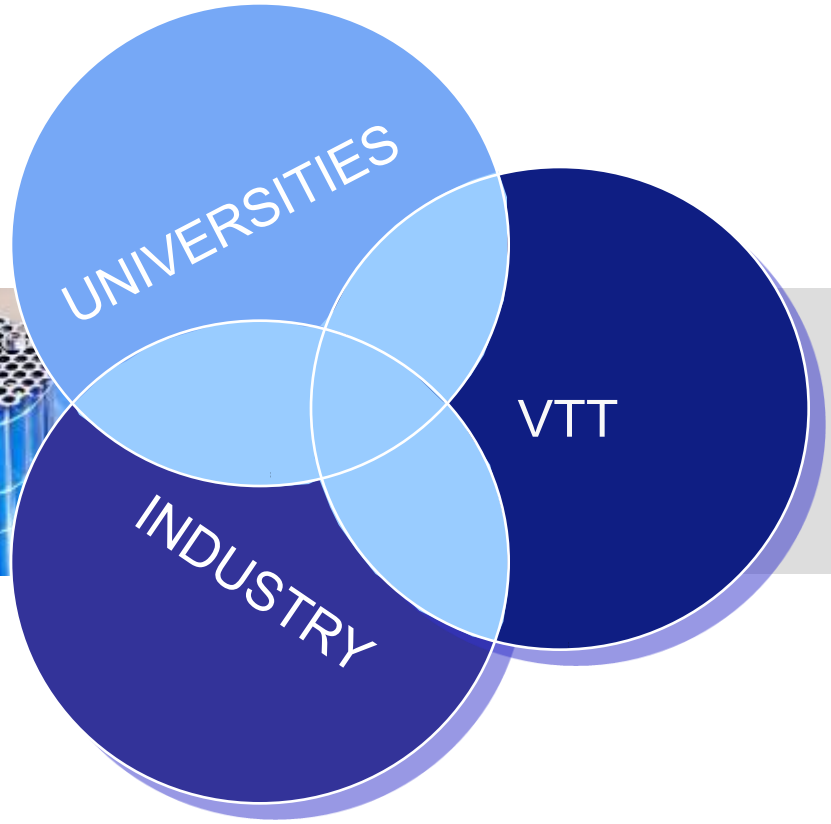
Agile industrial systems
- organisation and management of global manufacturing
- simulation based engineering
- eco-efficient machines
- human and organisational practices

VTT's status as performer of R&D work

Basic research

Applied research

Development



300 Universities and Companies

VTT on map


Saint Petersburg, Russia
Brussels, Belgium
Bay Area, USA
Seoul, South Korea
Tokyo, Japan
Shanghai, China
São Paulo, Brazil
Finland
Sodankylä
Rovaniemi
Oulu
Raahe
Kajaani
Kuopio
Jyväskylä
Outokumpu
Tampere
Lappeenranta
Turku
Rajamäki
Espoo
Helsinki

Micronova Research and Production infrastructure

Guest companies:

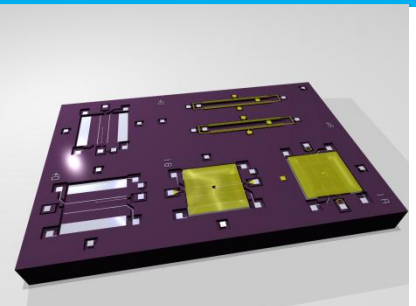
Advaplan, Aivon, Ajat, Beneq,
Nokia Research Center, Picosun,
Pixpolar, Vaisala, VTT Memsfab

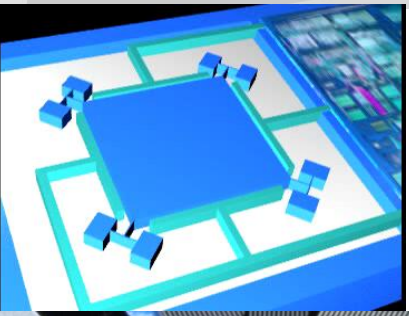
Large clean room **VTT & Aalto University**

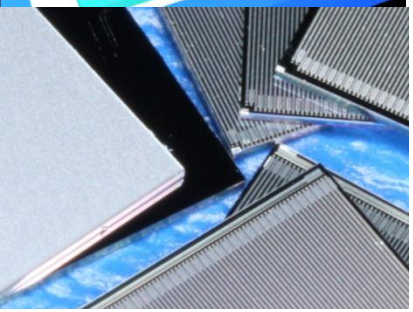
Basic research, Process development

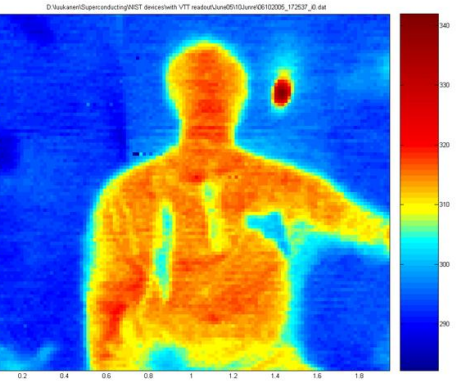
Device prototyping, Small Scale Production

100mm & 150 mm silicon wafers









Commercialization strategy

(High Performance Microsystems Program)

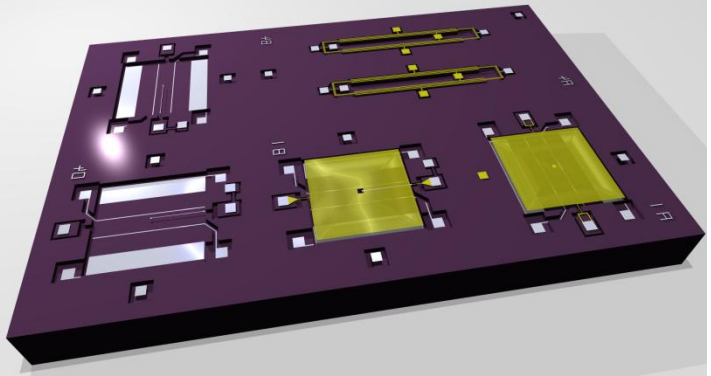
- **Productized world-class-level offering (technology + IP)**
- **Three product development lines**
  - *Sensors, Radiation Detectors, RF Modules,*
    (~ 50 patents/patent applications)

- **Two alternative commercialization channels**
  - **Lisencing out**
    (R&D contracts, technology transfer, IP lisencing)
  - **Joint ventures (access to the relevant VTT IP through the VTT IP apport to the start-up company)**

- **Contract manufacturing of micro and nanoelectronic devices at VTT MEMSfab (founded Jan 2011)**

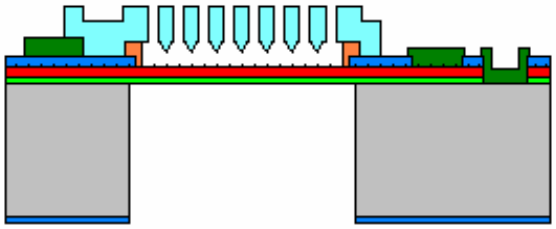
Sensors

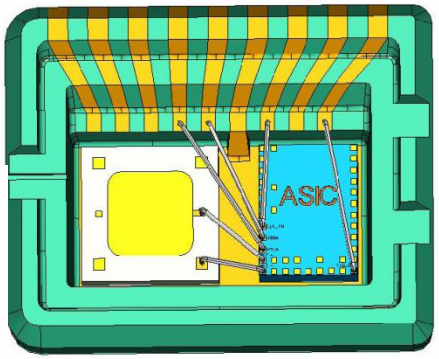
Magnetometer



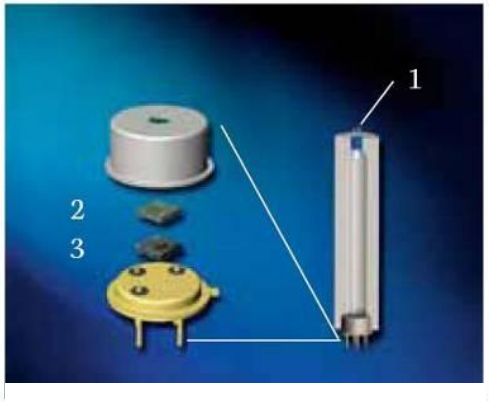
Inertial sensor

Pressure sensor





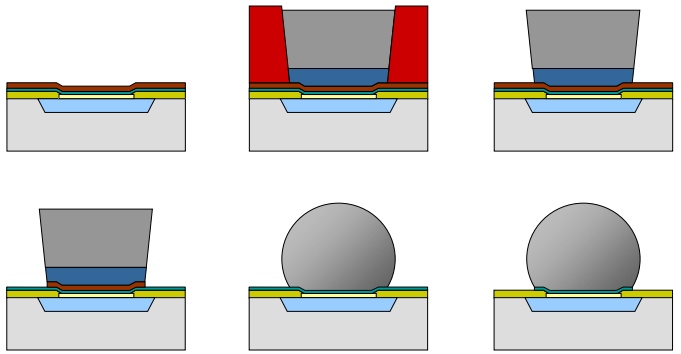
MEMS microphone



Microspectro-meters

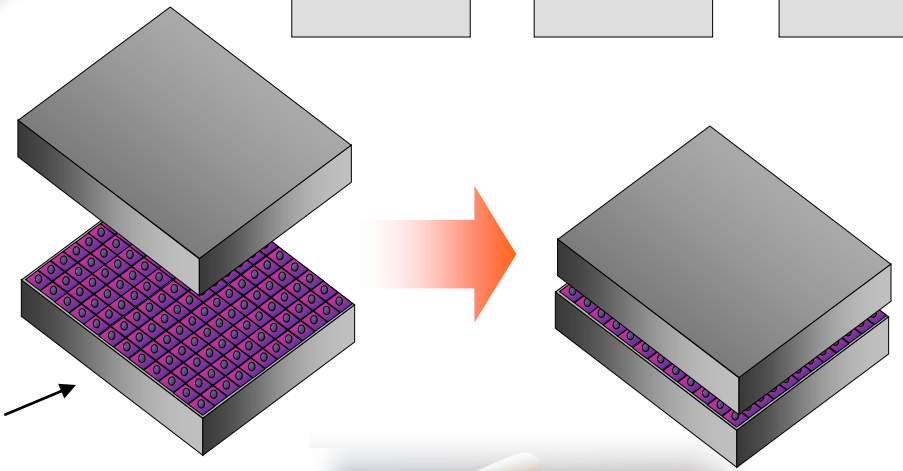
Radiation Detectors (X-ray, CERN)

Existing VTT product: hybridization of detectors and their assembly on large surfaces

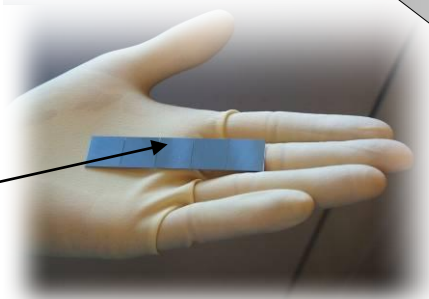


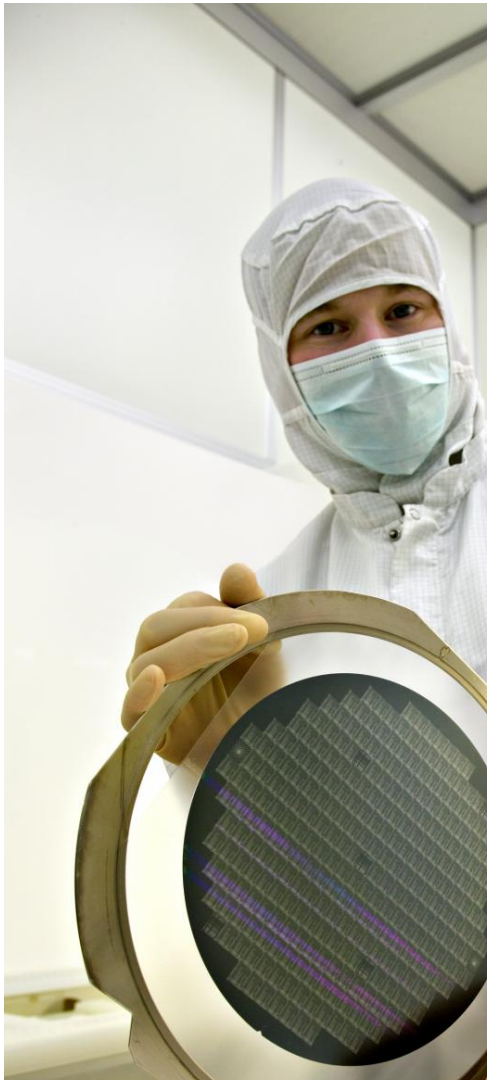
Silicon sensor

Electronics readout



Assembly with 5 readout circuits





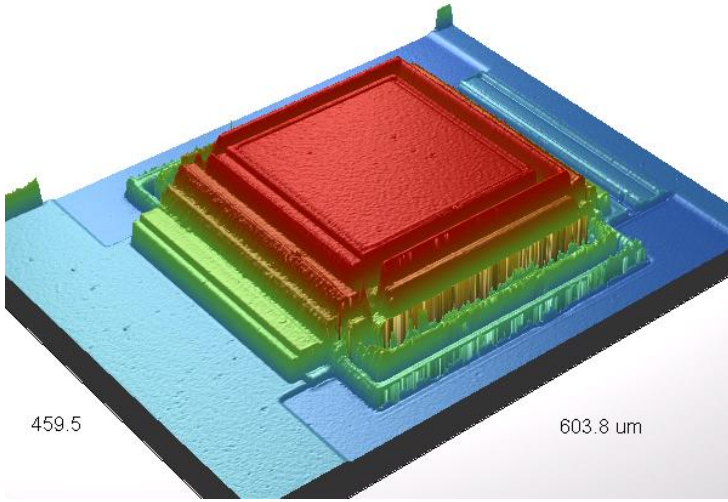
RF Modules

BAW filter technology

- Novel high-performance BAW filters

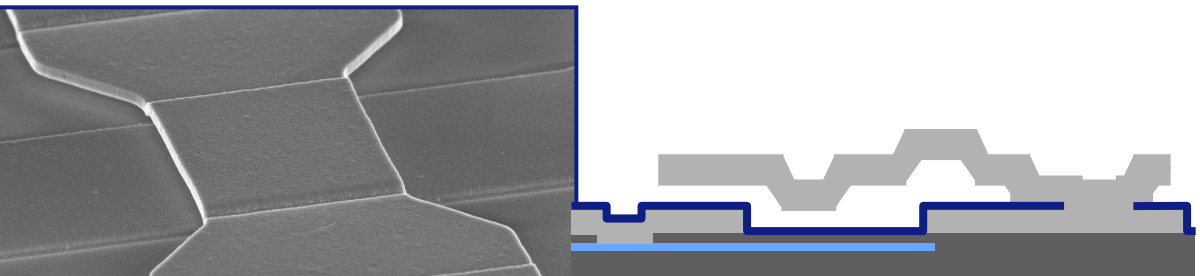
Integrated passive device (IPD) platform

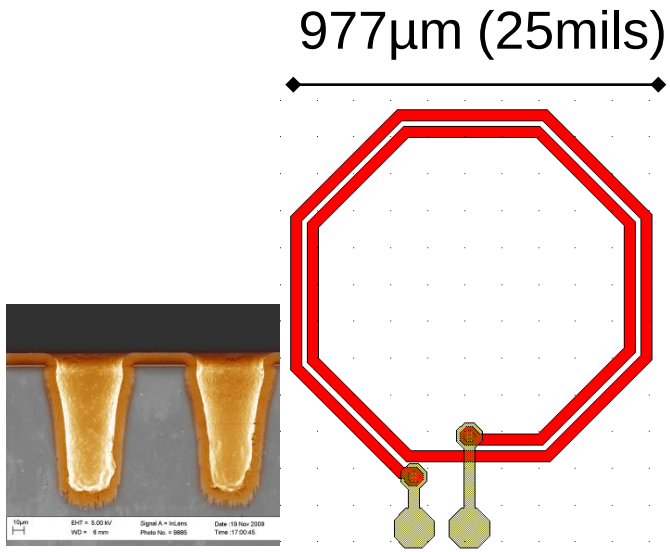
- Low-loss coils
- Metal-insulator-metal (MIM) condensators



Custom specific integrated circuit technologies

- Competitive advantage on low RF losses or on high voltage levels
- LDMOS





Electrochemical double layer capacitors (EDLC)

Need

- EDLCs (=Supercapacitors) facilitate short term high power energy storage for electronic devices, hybrid electric vehicles, renewable power production and smart grids.
- The cost and performance of EDLCs should be further improved in order to open up new markets.

Development steps

- Cylindrical EDLCs with activated carbon and organic electrolyte.
- Printed, disposable EDLCs with aqueous electrolyte.
- Hybrid capacitors with improved performance.
- Ionic liquid electrolytes.
- Large scale manufacturing by printing techniques.
- Application in industrial vehicles and buses.

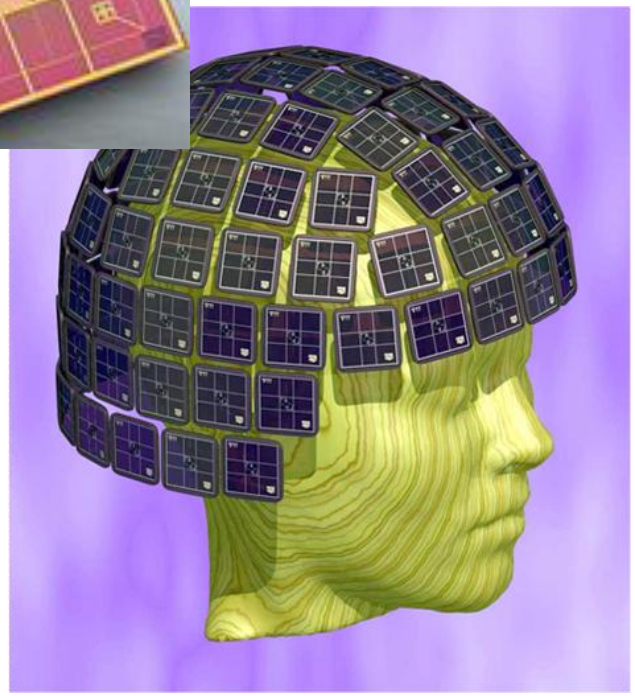
Results ≥ 50 F cyclindrical cells.

- Printed EDLC integrated with a disposable bio battery.
- Fuel cell – battery – EDLC triple hybrid forklift.

Cryogenic (4K) sensors and systems

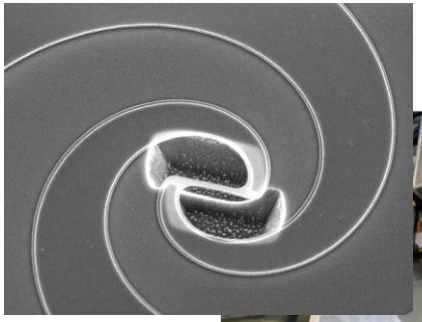
Superconducting SQUID magnetometer sensors

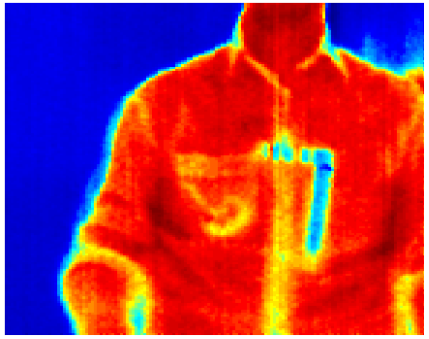
MEG human brain scanners



Superconducting bolometers

passive THz imaging systems

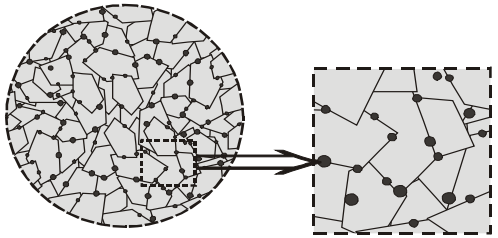




Coatings for extreme conditions

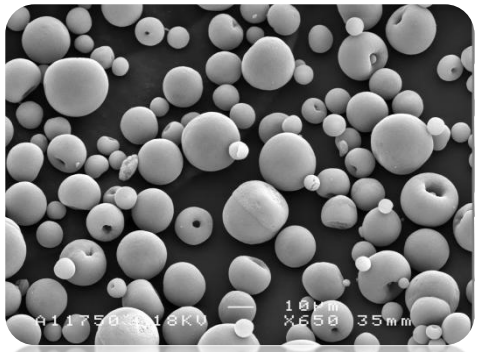
Utilizing nanostructures in thermal spraying - Ceramic coatings

Nano Ceramic powders → HVOF spraying → Improved strength, toughness and hardness and tailored wear performance

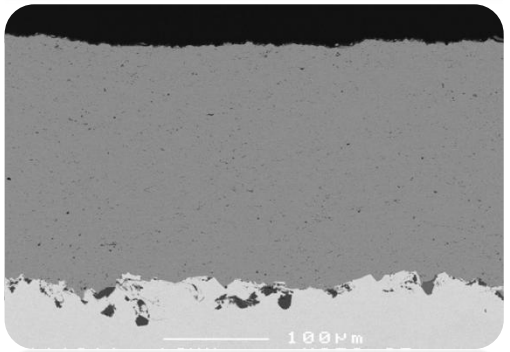


Dispersion strengthened ceramics

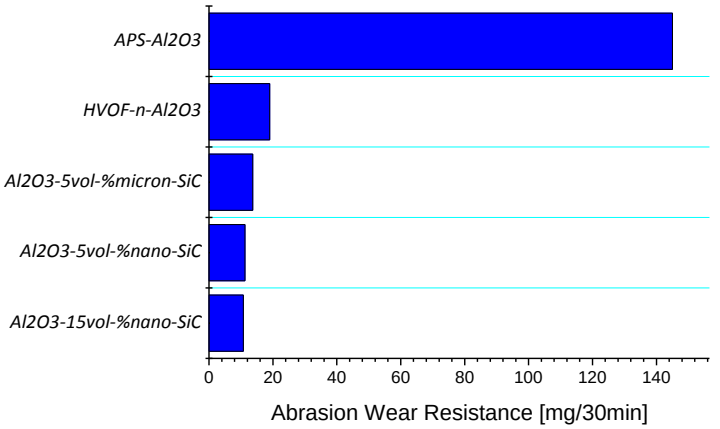
Praxair HV 2000



Nano oxide-oxide composite powder composition enabling amorphous coating structure



HVOF sprayed Al_2O_3-ceramic coating



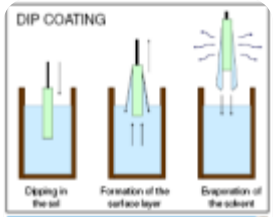
Improved abrasion wear performance by using nano SiC addition on Al_2O_3

Sol-gel coatings

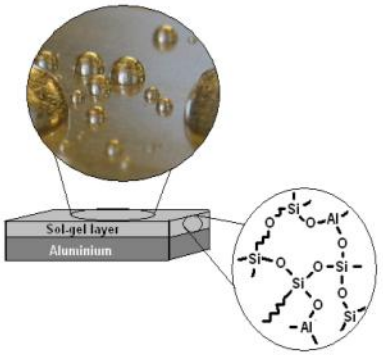
Coatings that are made by sol-gel technology are often thin and transparent. Typically the thickness ranges from 100 nm up to some micrometers. Coating does not necessarily change the appearance of the surface but gives some functionality.

Materials that can be coated:

- Metals
- Ceramics
- Glass
- Plastics
- Wood
- Painted surfaces …



Thermal or UV Curing



Functionality that can be achieved:

- Easy-to-clean
- Abrasion and scratch resistance
- Corrosion protection
- Barrier and moisture control
- Modification of surface free energy
- Photocatalytical
- Hygienic coating …

VTT's focus areas in plastics R&D

Plastic nanocomposites

- Enhanced performance of plastics
- Energy efficiency and environmental sustainability
- Biobased, biodegradable plastic solutions

Joining of plastics and embedded intelligence

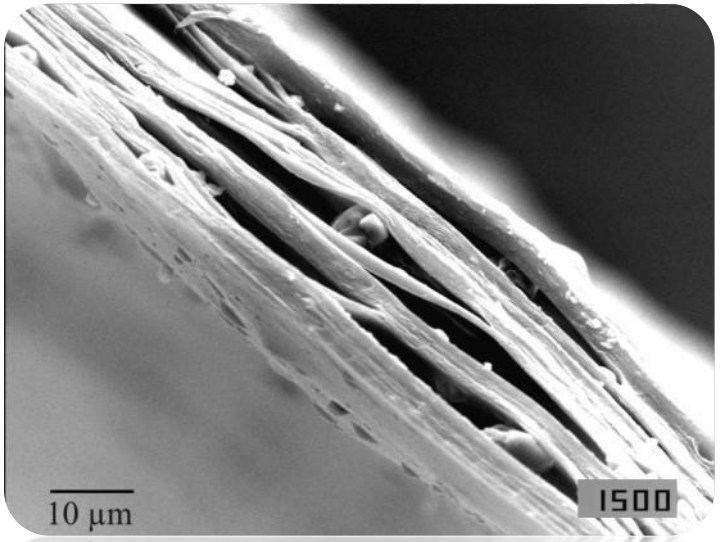
- Thermal management and adhesion
- Integrated structures
- Barrier films and encapsulation

Polymers with active functionality

- Actuators
- Sensors

Plastics processing

- Performance
- Feasiblity



SEM micrograph of PP/$CaCO_3$ film

Customers and partnerships in the HPM programme

Thank you for your attention!
We are open for discussoins

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Contract manufacturing of micro and nanoelectronic devices (founded Jan 2011)

www.vttmemsfab.com

- VTT Memsfab Ltd. carries out commercial production of microelectromechanical systems (MEMS) and other micro and nanoelectronic devices
- The company offers versatile contract manufacturing services based on extensive technical expertise and unique equipment environment

Oxygen catalysts for PEM fuel cells and electrolyzers

Need

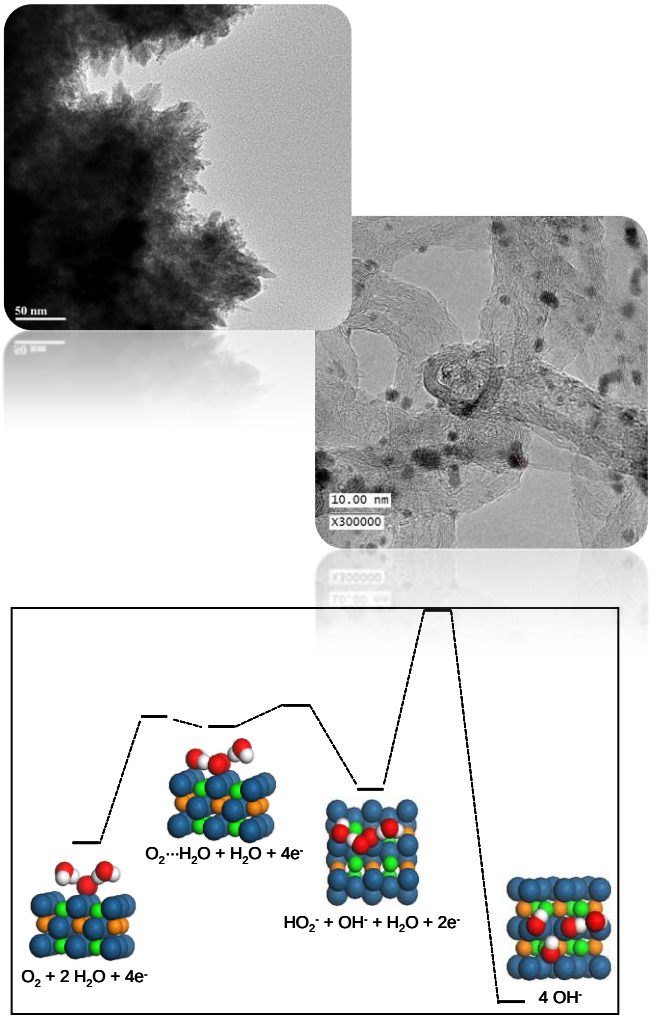
- Improved oxygen catalysts are needed in order to improve the durability and to reduce the cost of PEM fuel cells and water electrolyzers.
- Synthesis of Pt and mixed metal oxide nanoparticles for high electrochemical surface area.
- Partial replacement of Pt and Ir by alloying with cheaper metals, e.g. Co, Ni, Cr, Mn, Sn.

Development steps

- Molecular modelling of the different binary and tertiary Pt alloys and Ir based mixed oxides.
- Replacement of carbon black (CB) by carbon nano tubes (CNT) and fibres (CNF)as catalyst support.
- Analysis of catalyst performance and degradation mechanisms.

Results

- Synthesis of Pt on CNT and CNF.
- Improved durability of the Pt/CNF catalyst over Pt/CB.
- Synthesis of $Ir_xRu_yO_z$ mixed oxide nanoparticles



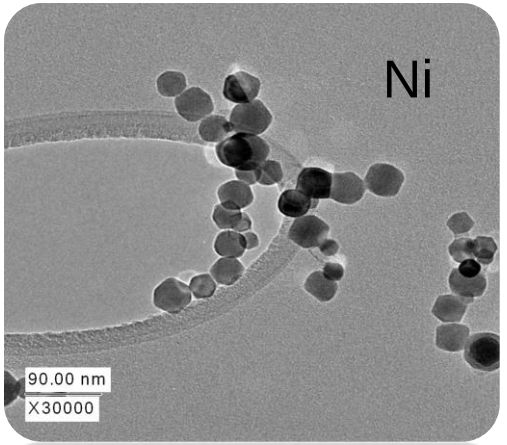
Synthesis and coating of metallic nanoparticles

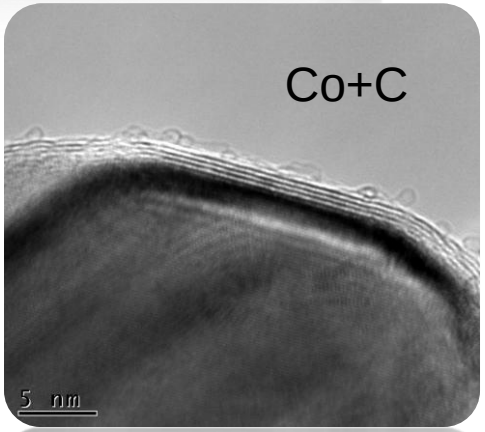
HCl-flame reactor

- Patent no. WO 0714445A
- Metal nanoparticle synthesis based on hydrogen reduction of gaseous metal-chlorides
- In situ graphene and Cu coatings
- Patent FI20096317A and FI20105126A

iNucleation

- Metallic nanoparticle production by induction heating
- Gas phase coating of metallic nanoparticles by e.g. organic compounds (L-Leucine and PAA).
- Patent appl. FI20096162





VTT creates business from technology