CATMAT - 3.12.04
Forskningsutfordringer

- **Behov innen rekruttering og forskning**
- **Utfordringer innen nanoteknologi**
- **Fischer-Tropsch teknologi**

STATOIL

Industriens behov

- ***Hva er industriens (Statoils) behov?***

1. ***Kandidater på siv.ing., master og PhD nivå med***
   - ***Bakgrunn i katalyse fra kjemi, syntese, mekanismer, kinetikk, testing, karakterisering og reaktorteknologi.***
   - ***Både laboratorie- og teoretisk bakgrunn.***
   - ***Ferdigheter innen forsøksplanlegging, data-analyse og rapportskriving.***

2. ***Forskningsaktivitet på topp internasjonalt nivå på universiteter og forskningsinstitusjoner.***

3. ***Forskning på industrielt viktige problemstillinger.***

Rekruttering

- ***Kandidater på siv.ing., master og PhD nivå med***
  - ***Bakgrunn i katalyse fra***
    - ***kjemi***
    - ***syntese***
    - ***mekanismer***
    - ***kinetikk***
    - ***testing***
    - ***karakterisering og***
    - ***reaktorteknologi.***
  - ***Både***
    - ***laboratorie- og***
    - ***teoretisk bakgrunn.***
  - ***Ferdigheter innen***
    - ***forsøksplanlegging***
    - ***data-analyse og***
    - ***rapportskriving.***

Rekruttert (NTNU-katalyse)

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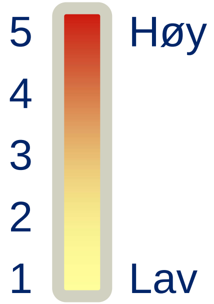
Forskningskompetanse



- ***Forskningsaktivitet på topp internasjonalt nivå på***

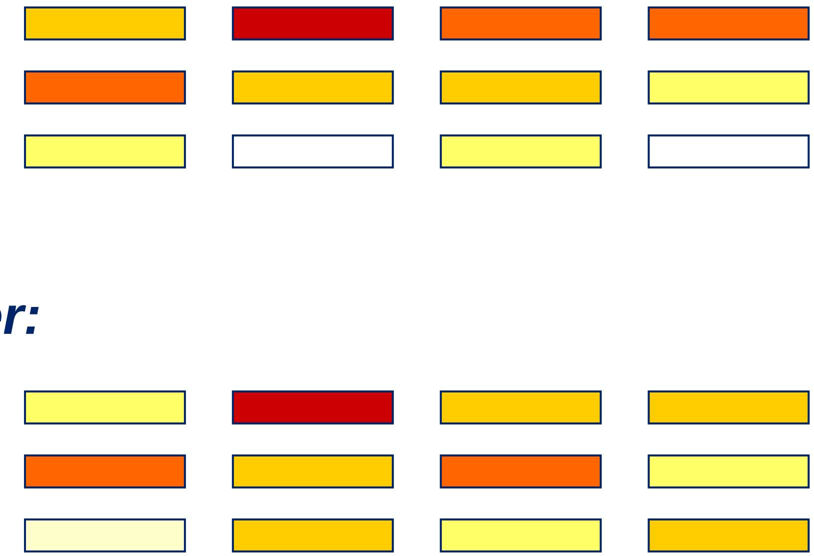
Universiteter:

Syntese Testing Karakt. Reaktor

- ***NTNU***
- ***UiO***
- ***UiB, UiTø***

Forskningsinstitusjoner:

- ***Sintef Trh***
- ***Sintef Oslo***
- ***IFE***



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Nye kat. prosesser og konsepter I Statoil

- *Katalytiske prosesser av interesse*
  - *Gassforedling*
    - *Metanol*
      - *MTP*
    - *Syntesegass*
    - *Dehydrogenering*
    - *Polymerisering (Borealis)*
    - *Hydrogenering*
    - *GTL (Fischer-Tropsch)*
    - *Hydrogen/Kraft/FC*
  - *Oljeforedling*
    - *Hydrogeneringsprosesser*
    - *Isomerisering*
    - *Reforming*
    - *Oligomerisering (Poly)*
    - *Cracking*
    - *Oppgradering av tungolje*

Egen kat. teknologi

Utvikling sammen med leverandør

Kat. teknologi som del av nytt konsept

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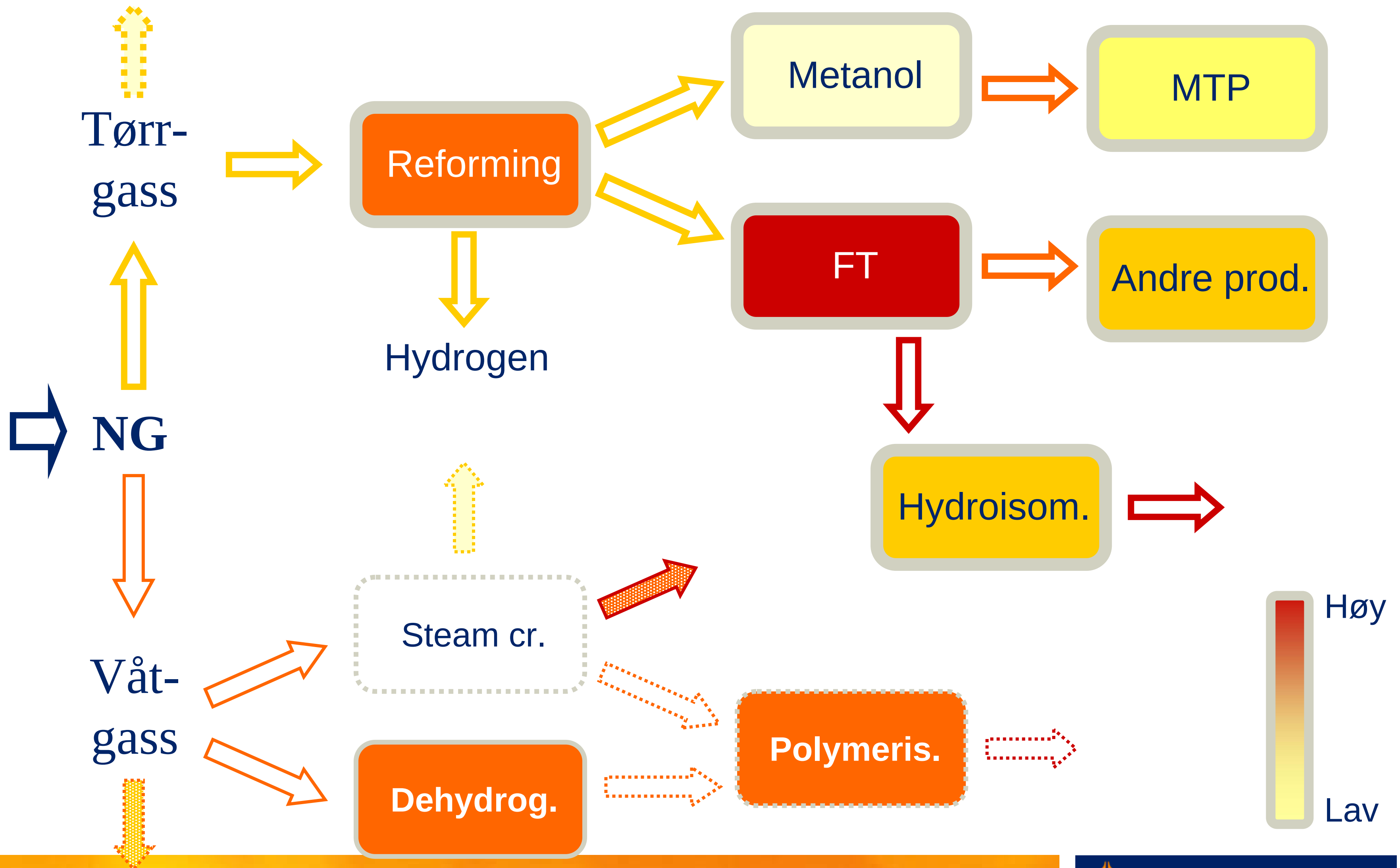
Gassforedling – katalyse R&D



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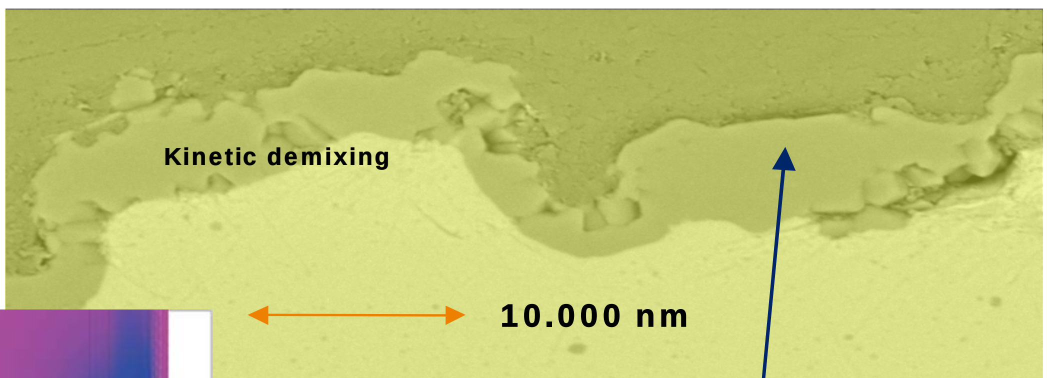
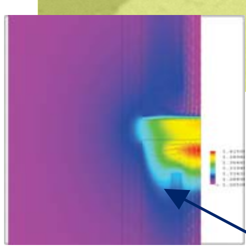
Nanotechnology

Example from oxygen ion membranes

- **100 % selective oxygen generation from air.**
- **Applications:**
  - **Oxygen for medical use**
  - **Hydrogen / el. generation from coal, biomass or natural gas**
  - **Production of chemicals and synthetic fuel**

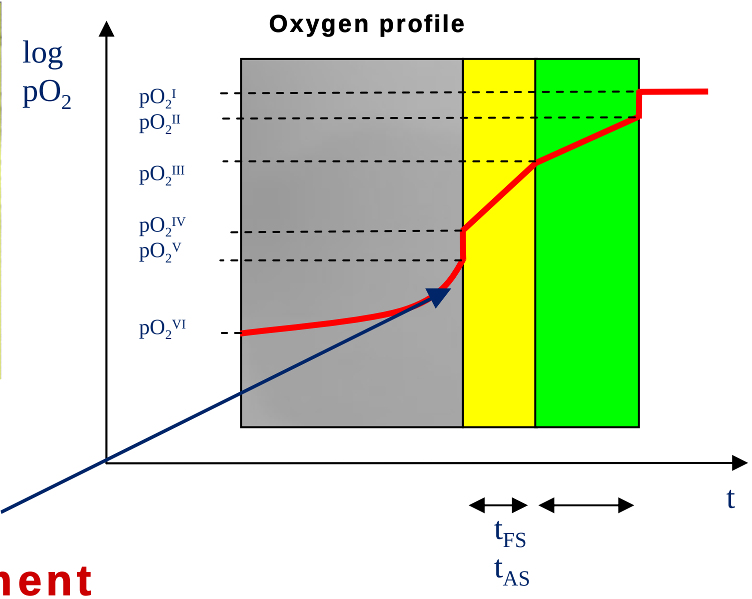




Exothermal / endothermal reactions

NanoCHALLENGE

- **Interphase growth / stability**
- ***In situ* oxygen measurements**
- ***In situ* temperature measurement**



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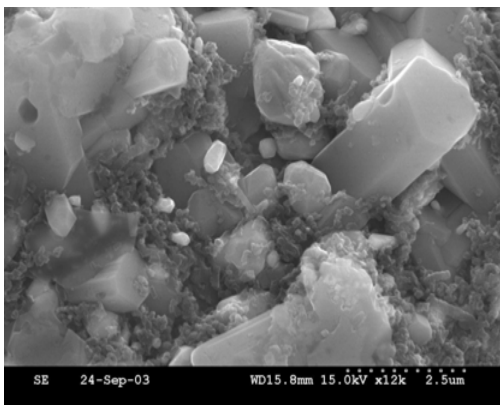
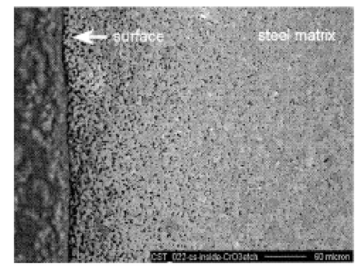
Example from corrosion

- New alloys potentially resistant to metal dusting
- Contains Fe, Cr, Ni, Al. Diffusion and oxidation create a protective alumina surface layer



New alloy

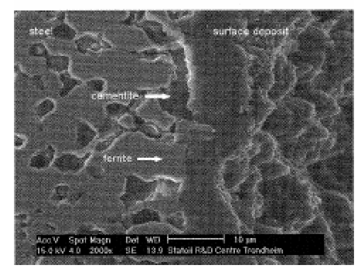
Adverse effect of impurities after 2 years of exposure



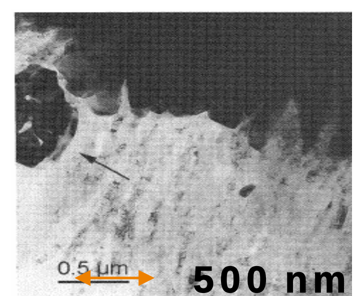
(a)

Metal dusting of mild steel

Optical microscope



SEM



TEM showing fragmentation and decomposition

NEED
- Accelerated test
- Nano-resolution
- In situ depth profiling
  - Effect of T, P, gas composition
  - Crystal growth, interphases

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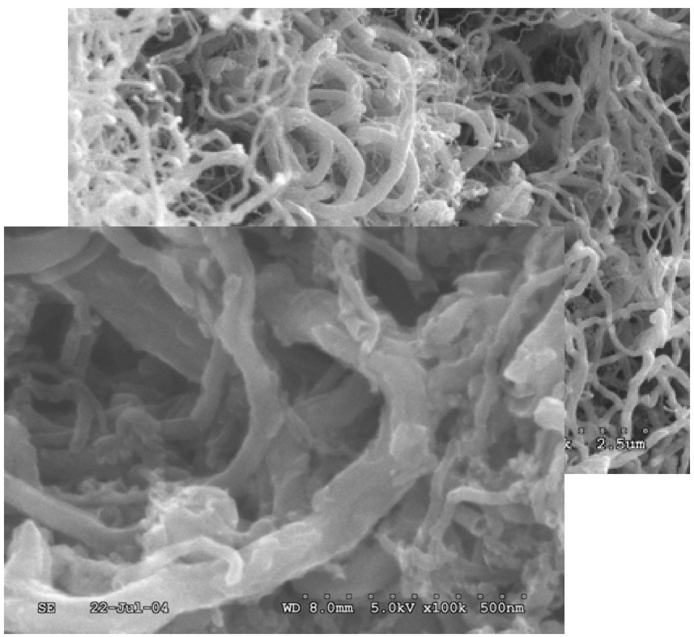
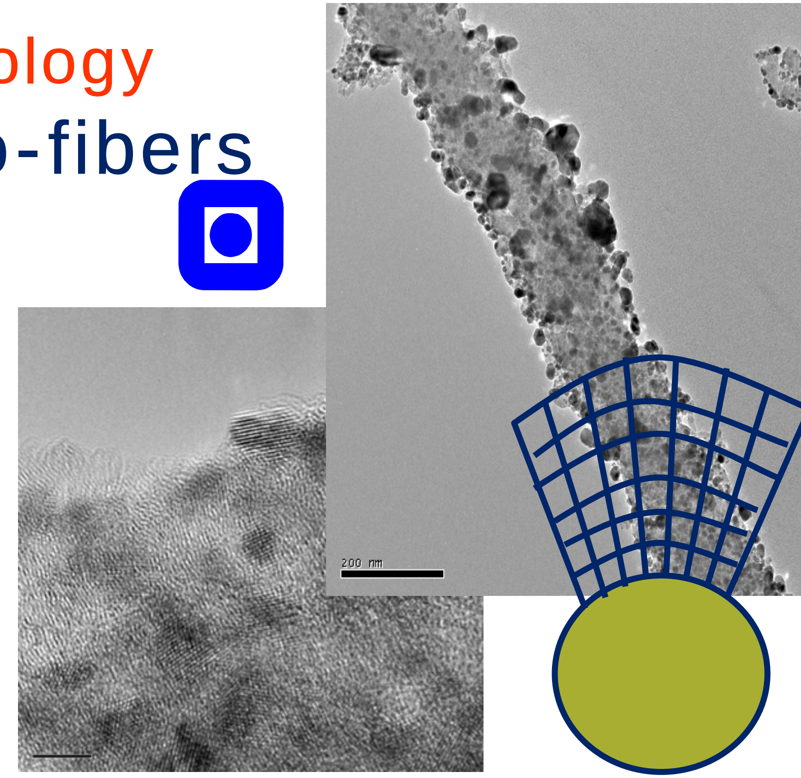
Nanotechnology

Example from carbon nano-fibers

- Extremely active R&D field
- Many potential applications



Industrial sample for metallurgical use



Deposits on CNF modifies materials properties

NEED

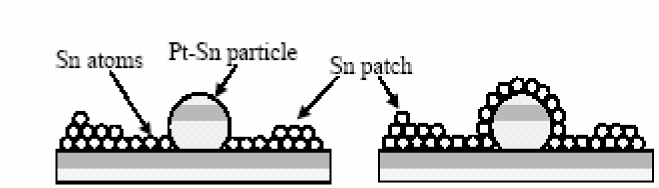
- Better understanding of
  - surface properties
  - interface properties
  - adsorption mechanism
  - ++++

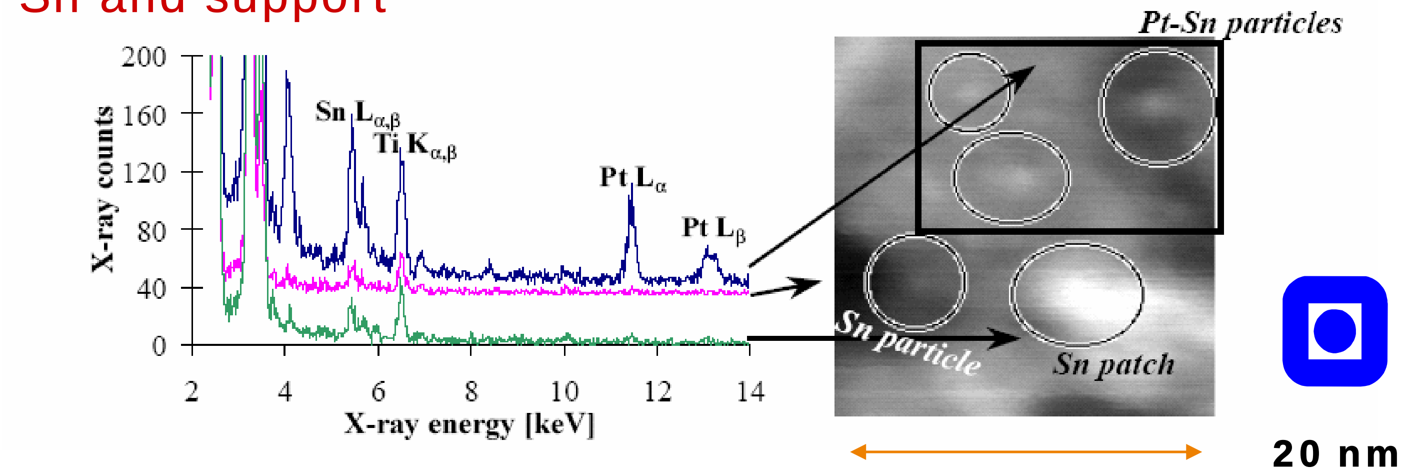
Example from Dehydrogenation

- Olefins as polymer feedstock
  - Dehydrogenation of propane
  - Platinum/tin on a basic support (hydrotalcite)

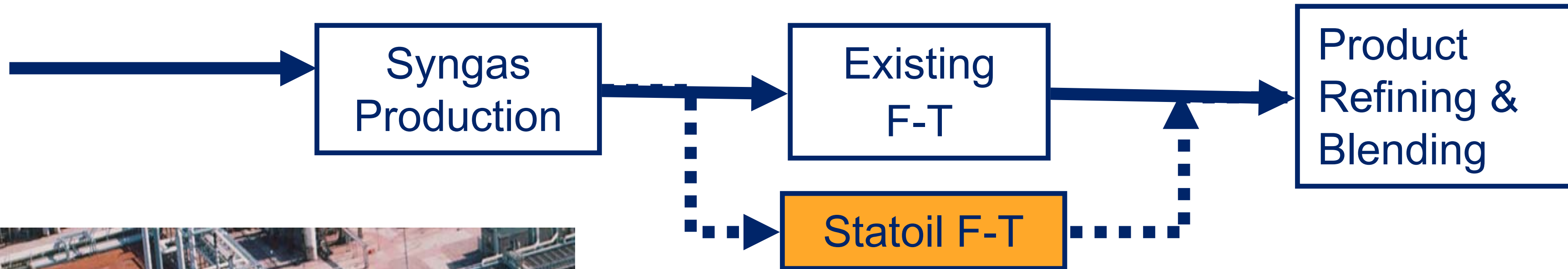
CHALLENGE:

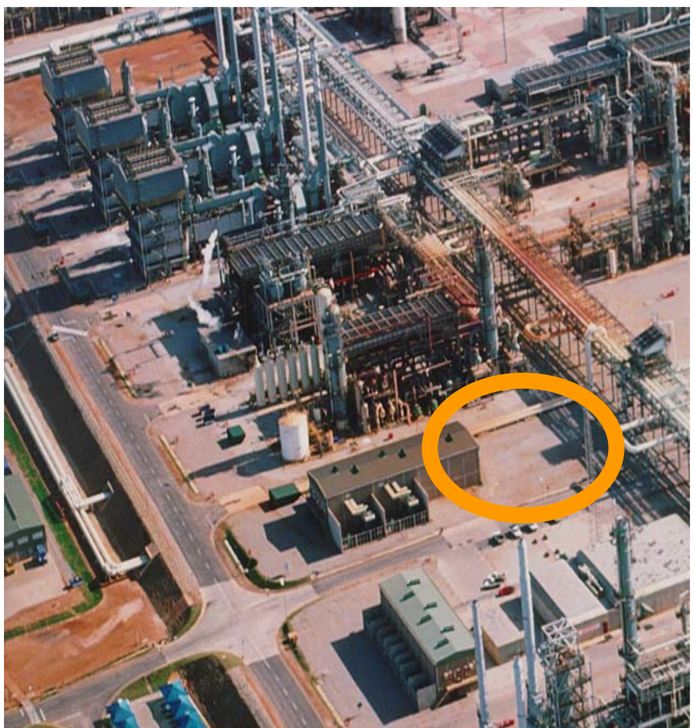
- Low contrast
- Cumbersome statistics
- *In situ* conditions
- Effect of Sn and support





The GTL technology





The project is a joint venture with Petro SA, which operates the worlds largest GTL plant, producing about 30 000 bbl/day of high quality fuels from natural gas fields offshore Mossel Bay.

The new demonstration plant will use synthesis gas produced by the existing GTL plant, and the products will be integrated into the existing product refining, blending and storage facilities.

The GTL technology

Natural gas → Syngas production → $CO+CO_2+H_2$ → Fischer-Tropsch synthesis and upgrading → Naphta, Diesel, Other products

Semi-commercial plant, Mossel bay, South-Africa:

Production capacity : Up to 1000 bbl/d of oil and wax

Start-up : 2Q 2004

Investment cost : about NOK 500 mill.

Contractor : Technip SpA Italy

Project execution : Petro SA

Technology licensor : Statoil

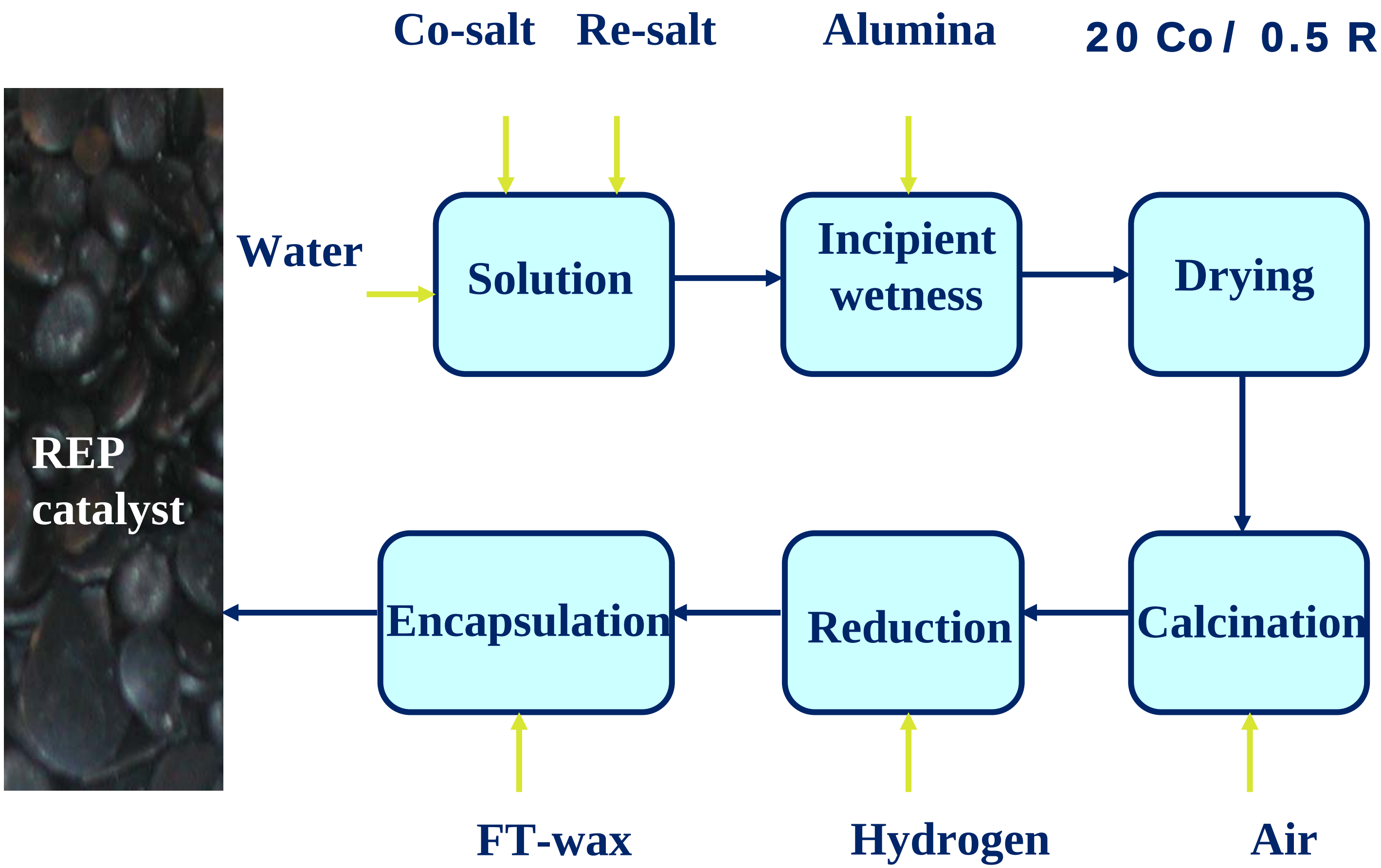
The GTL technology

- Statoil's technology for converting synthesis gas to liquid hydrocarbons involves a patented catalyst and reactor design.
- A high performance cobalt-based catalyst has been developed since 1986, and commercial scale production now has been demonstrated by Johnson Matthey Catalysts

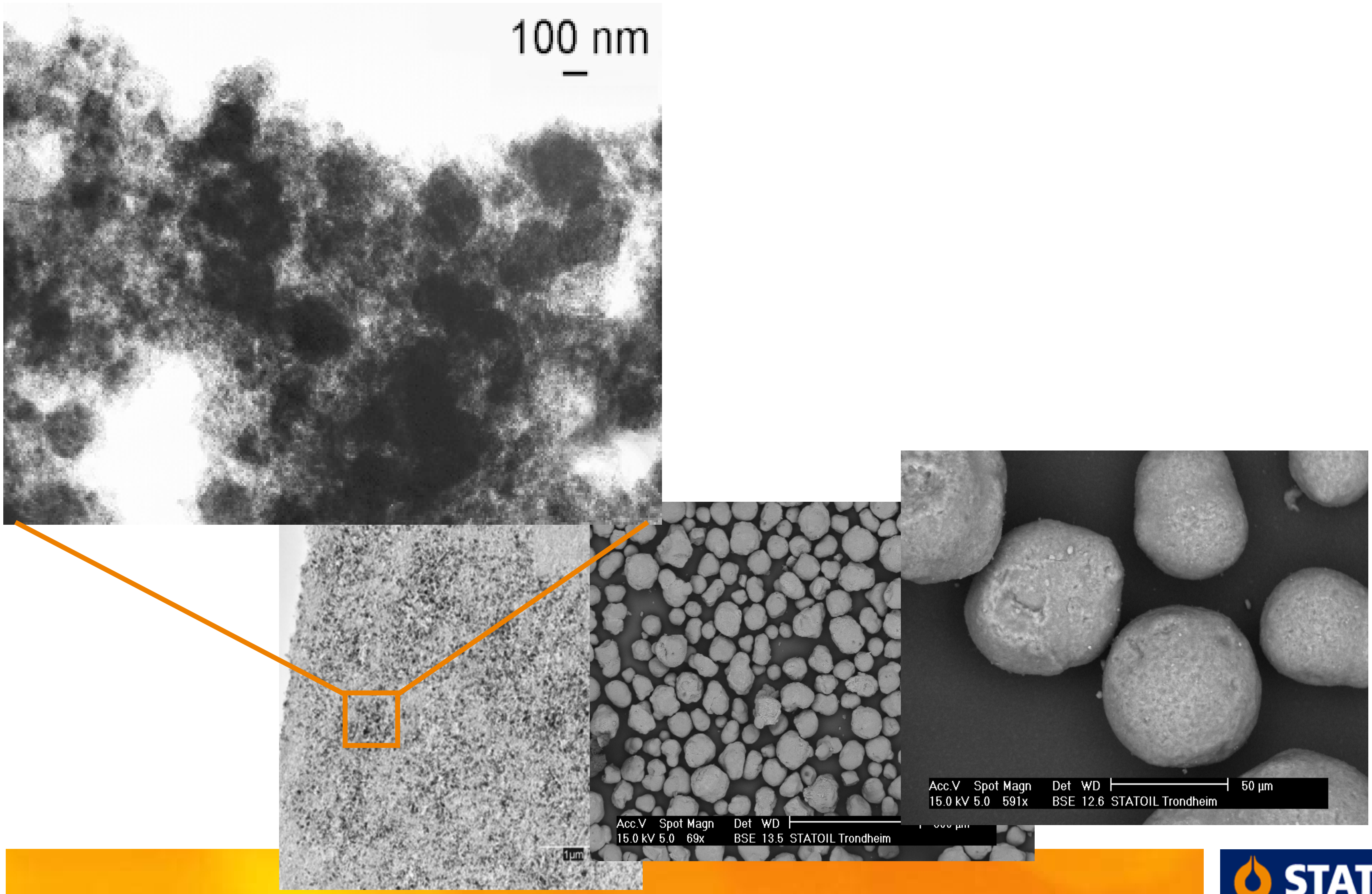
The GTL catalyst preparation

Standard composition:

20 Co / 0.5 Re on γ-alumina



The GTL catalyst



Example from Fischer-Tropsch

- Fischer-Tropsch synthesis of synthetic fuel
  - Promoted Co catalyst on an inorganic oxide support

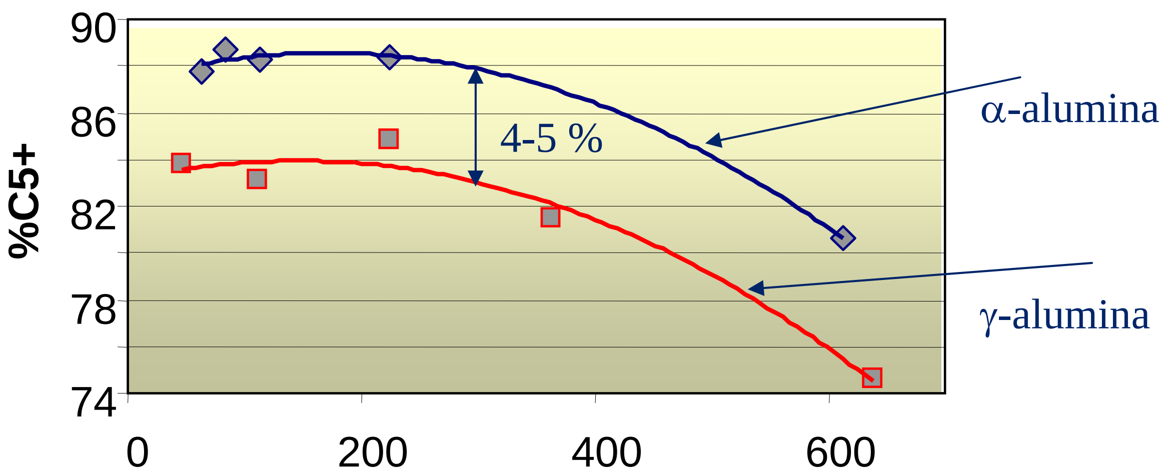
CHALLENGE:

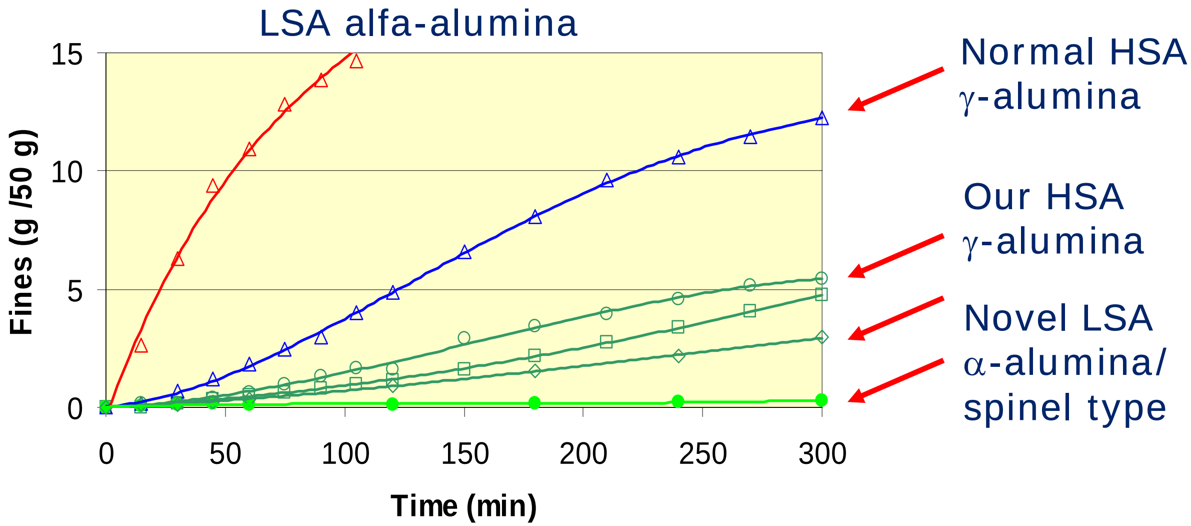
- Where is the promoter and how does it work?
- How is Co attached to the catalyst support?
- How does cobalt particle size and distribution change under activation and operation?

0.09 nm resolution
BUT
- **Need high promoter level**
- **No quantification**
- **No distribution Co / support**
- **Industrial conditions difficult**

CATMAT 3.12.04 Fischer-Tropsch

Effect of the alumina support





- ***25 – 40 % less methane and light hydrocarbons***
- ***Implications for higher product yield, reduced investment, lower CO_2 emissions, and possibly increased train size.***

STATOIL

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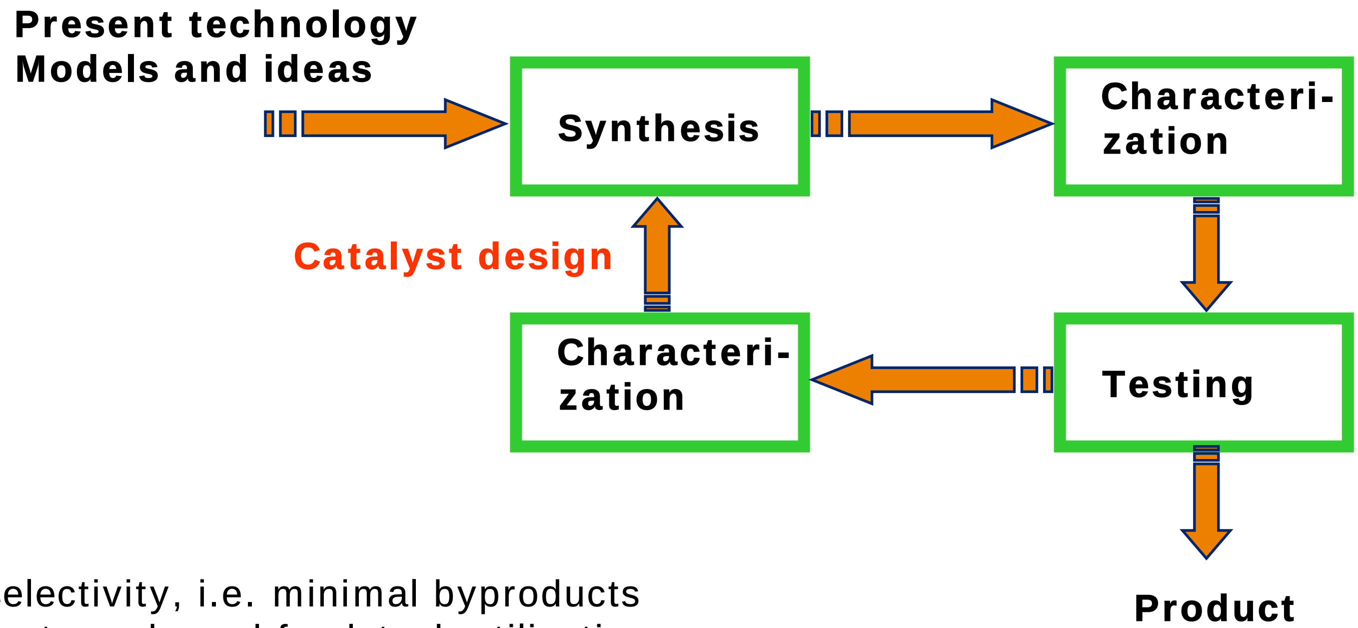
How can we do it?

- Catalytica Inc. advocated 20 years ago catalyst engineering by design:



- High selectivity, i.e. minimal byproducts and waste and good feedstock utilization
- High activity, i.e. efficient process and reduced material usage
- High stability and physical integrity, i.e. easy operation and low catalyst cost

- It never worked
- Will it work today?