MERITS
A RECHARGEABLE HEAT BATTERY

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Coatings for Heat Storage Reactors with Hygroscopic Salts (MERITS project)

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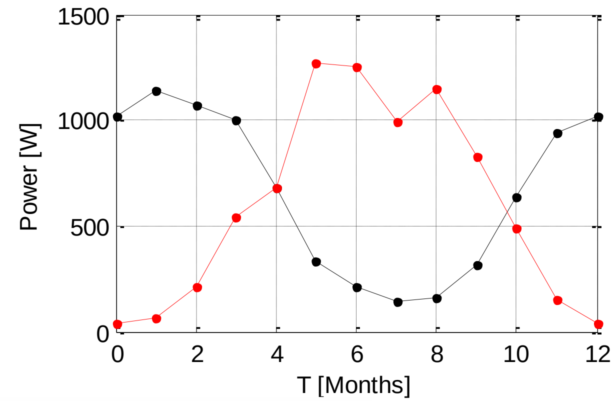
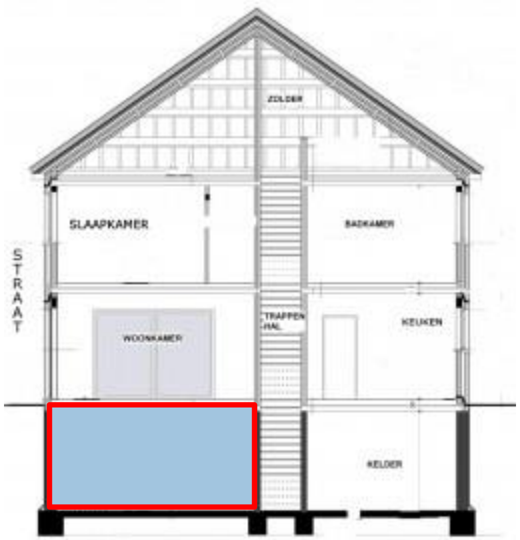
Contents

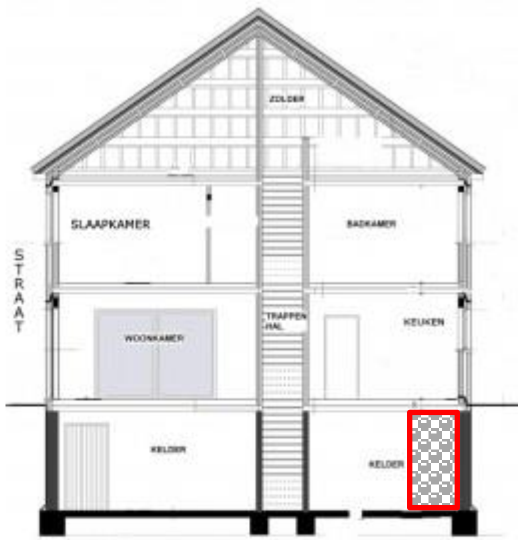
- Seasonal Heat Storage
- MERITS Programme
- Thermochemical heat storage system
- Corrosion protection
- Testing of coated samples
- Conclusions

Seasonal Heat Storage for the build environment

- Business case
  - Yearly heat demand of single family dwelling versus solar energy supply
  - Typical house in NL → Store 10GJ for cold season
  - Hot water storage 90°C → 50m^3
  - Thermochemical storage → 5m^3 (compact)

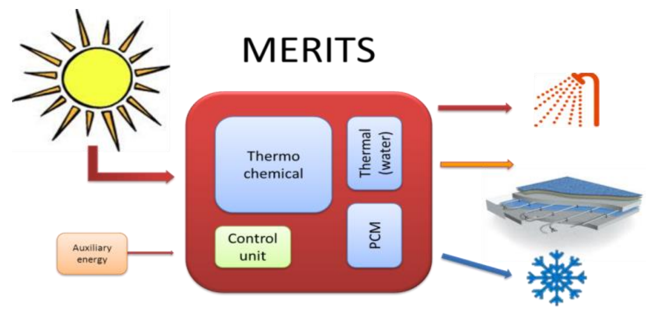






European 7th Framework Programme MERITS

- The international MERITS consortium is working on a new solution for
  - improved use of renewable sources
  - for heating and cooling and hot water applications
  - in individual dwellings (new & existing)
- for all three European climate zones



- The aim is
  - to build a prototype of a fully functioning compact rechargeable thermal battery
  - that would fit in for example a cellar or underground a garden
  - including business models and market strategies to foster market take-up before 2020

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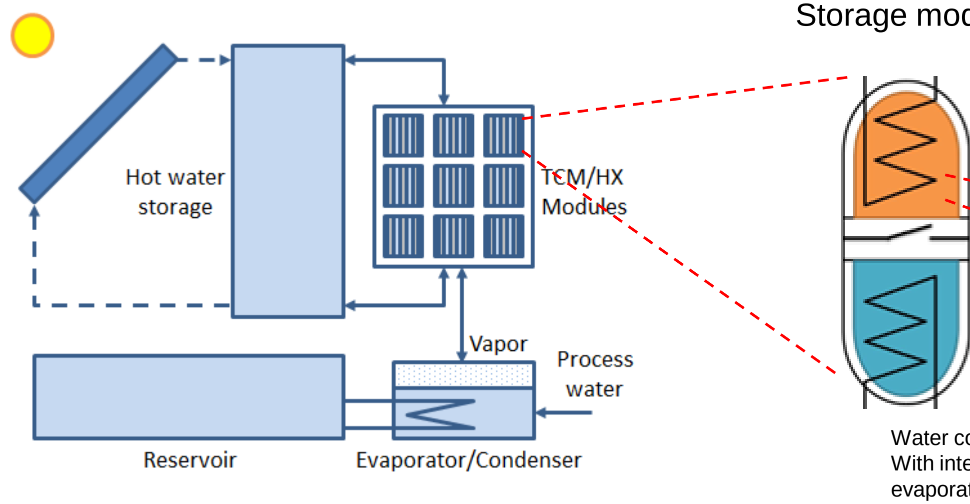
Thermochemical heat storage (TCS) system

Storage module



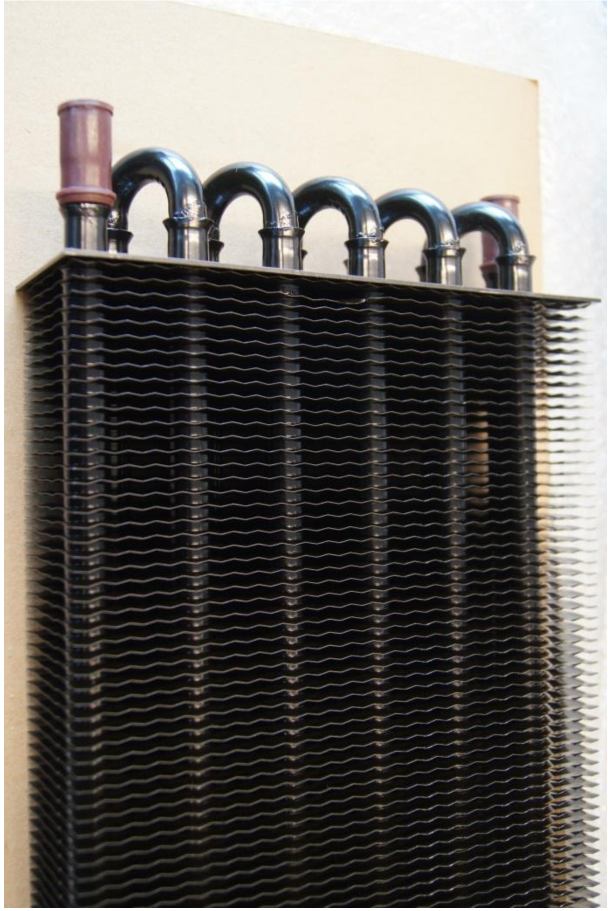
Thermo Chemical Material (TCM) Na_2S

- System level[1]
  - Balancing supply & demand
  - Dimensioning heat & power
  - Open/closed system?
  - Vacuum/atmospheric?
- Component level
  - HX implementation
  - **HX corrosion prevention[2]**
  - Evap/Cond implementation
  - Reservoir implementation
- Material level
  - TCM type
  - Composite TCM development[3]
  - Cycling stability
  - Q/V, vapor & heat transport

[1] *AJ de Jong et al, SHC 2013*　[2] *This presentation*　[3] *M. Roelands et al, SHC 2014*

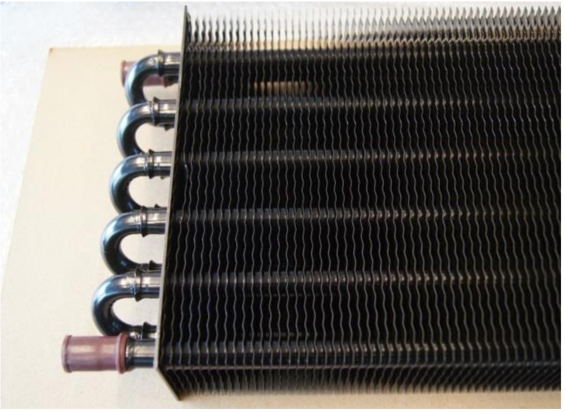
Corrosion protection of heat exchanger (HX)

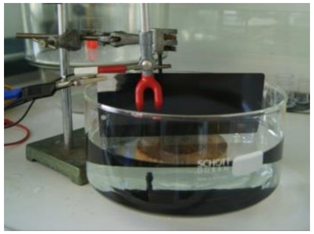
- Preferred HX for MERITS
  - Cu tubes, Al fin plate → Low cost, mass production, good heat conductivity
- Challenges
  - Protect Cu and Al in corrosive Na_2S environment (coating)
  - Complex geometry & sharp fin plates → Difficult for coating application(!)
  - Non-destructive coating testing for all HX used within MERITS system



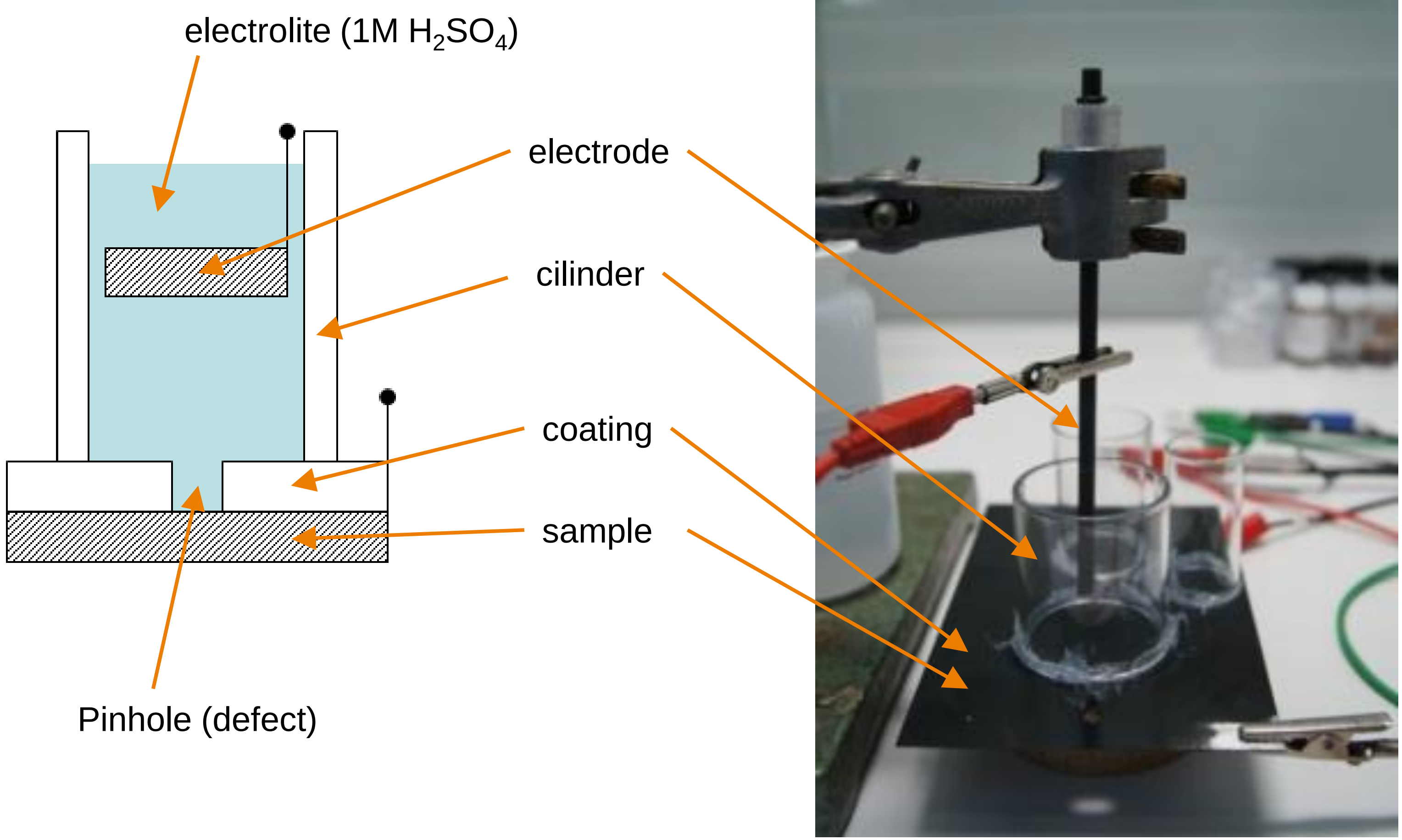
Coating testing

- Testing methods
  - Visual inspection
  - Electric Impedance Spectroscopy → Pinholes
  - Exposure to Na_2S, vacuum, T-changes
- Samples (Epoxy coating applied by E-coating)
  - Flat samples
  - Complete Heat Exchanger





EIS flat samples – Setup

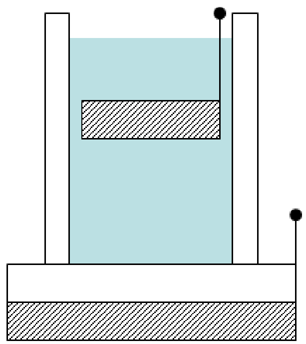


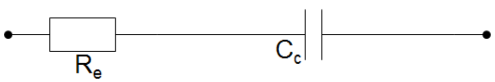
EIS flat samples – Method

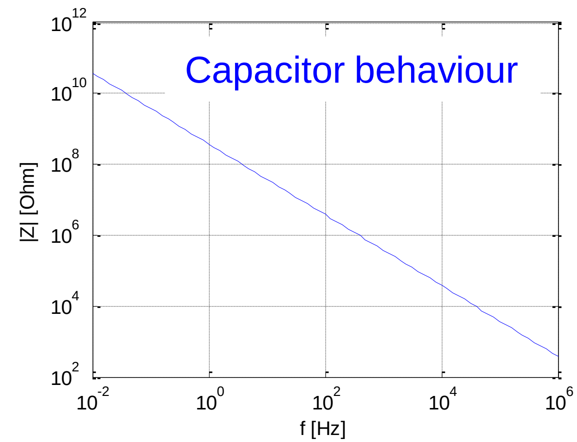
- No defects

Equivalent network

Bode plot

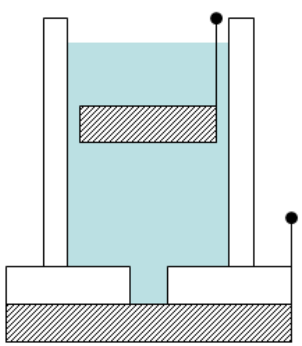


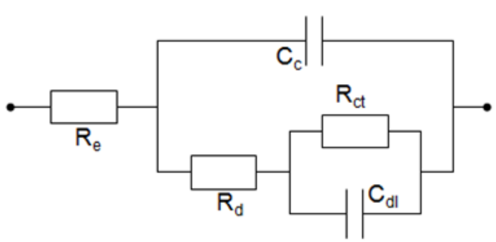


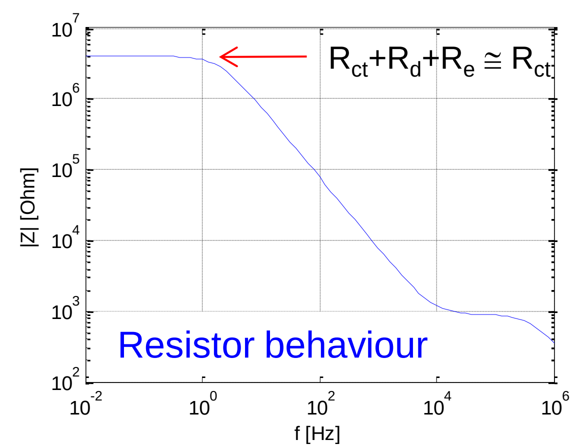


- Pinhole present

R_{ct} = charge transfer resistance
$\propto$ 1/defect area







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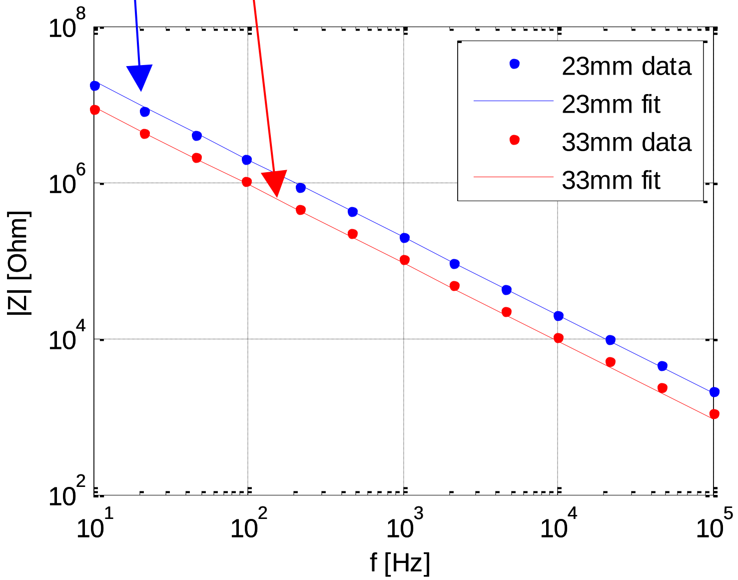
EIS flat samples – Results

1. Straight line → no defects

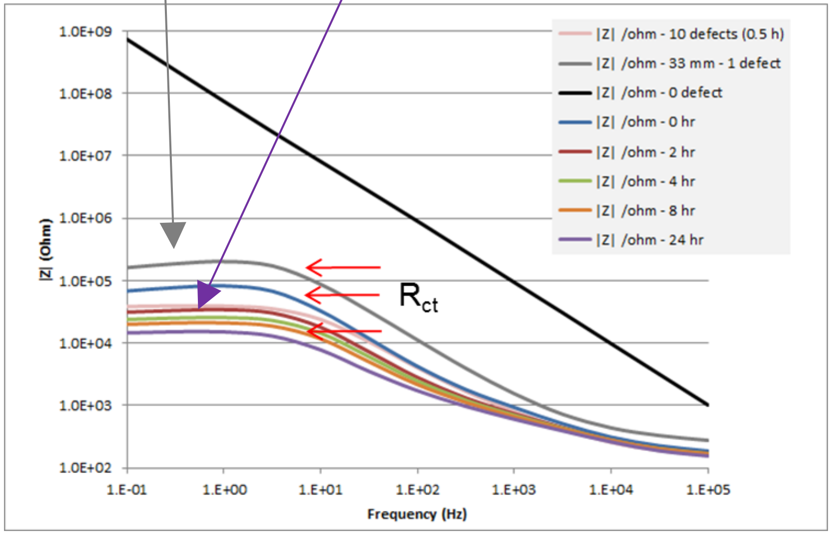
2. Height scales with area → no stray capacity

3. Since R_{ct} is related to the defect area we can use the artifical defect with known area to calibrate the measurement

4. If the impedance spectrum is monitored for 24h the defect develops (R_{ct} decreases)



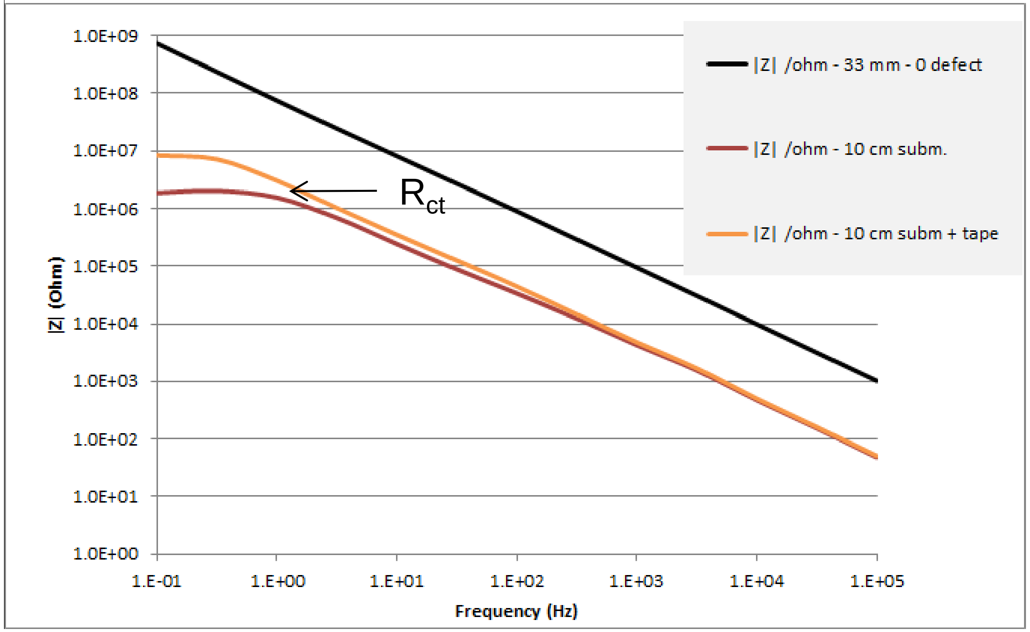
No defects

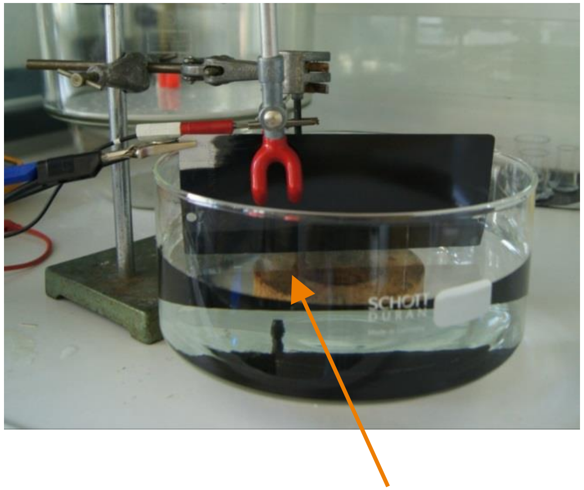


Artificial defect (puncture)

EIS flat sample – Results for edges

- No perfect Capacitor behaviour → Are edges more prone to defects?
- Edges covered with tape → Reduced defect area!
- Microscopy → Bubbles, pinholes near edges

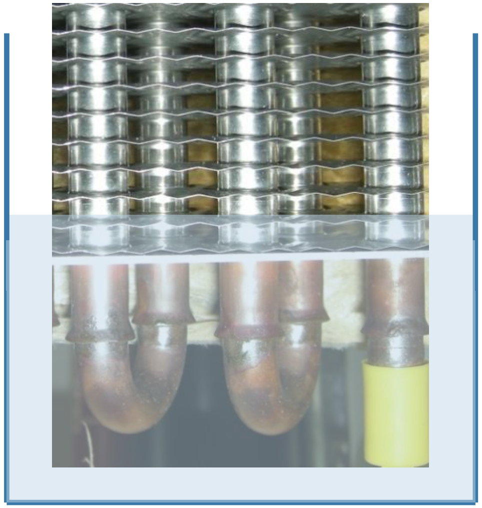




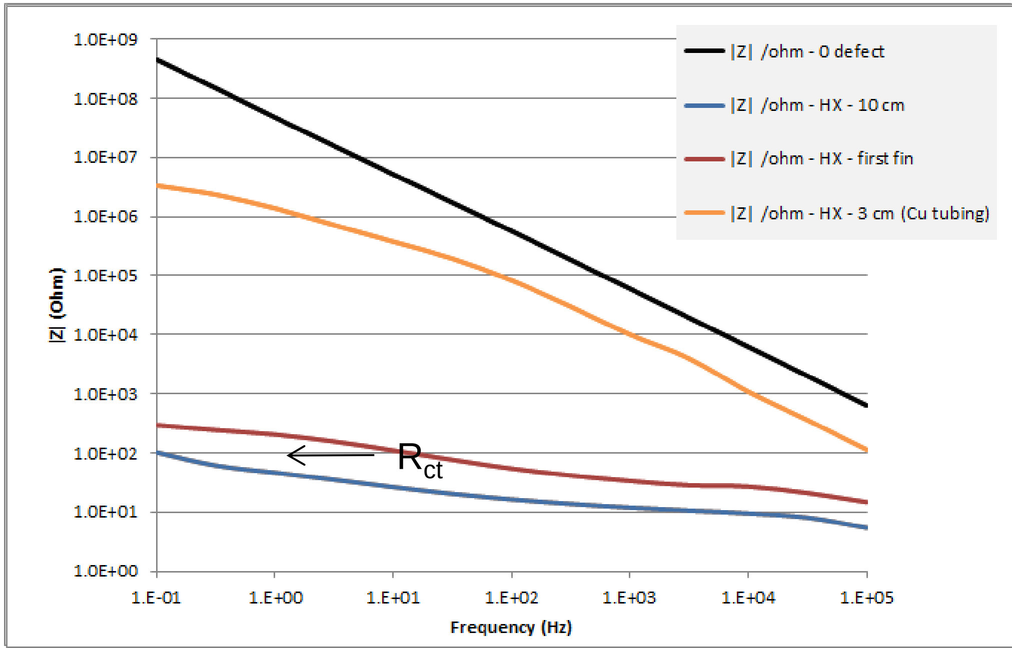
Edges immersed

EIS of complete heat exchanger

- Immersion of only Cu tubing → Acceptable
- Immersion until first fin → Defect area ≅ 10mm^2
- Immersion 10cm → Defect area ≅ 30mm^2
- Conclusion → heat exchanger coating contains pinholes



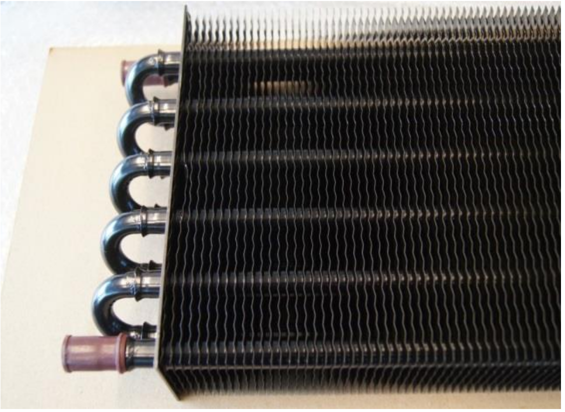
Large set-up for immersion of whole HX = 60x20x5cm^3(!)



Conclusions

- Conclusions impedance testing
  - Valuable electric impedance setup realized for coating testing!

- Conclusions HX coating
  - Surface of flat Al-samples contains no defects
  - Edges of flat Al-samples are prone to defects
  - Heat exchanger shows defects on fins



Thank you.

www.merits.eu

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