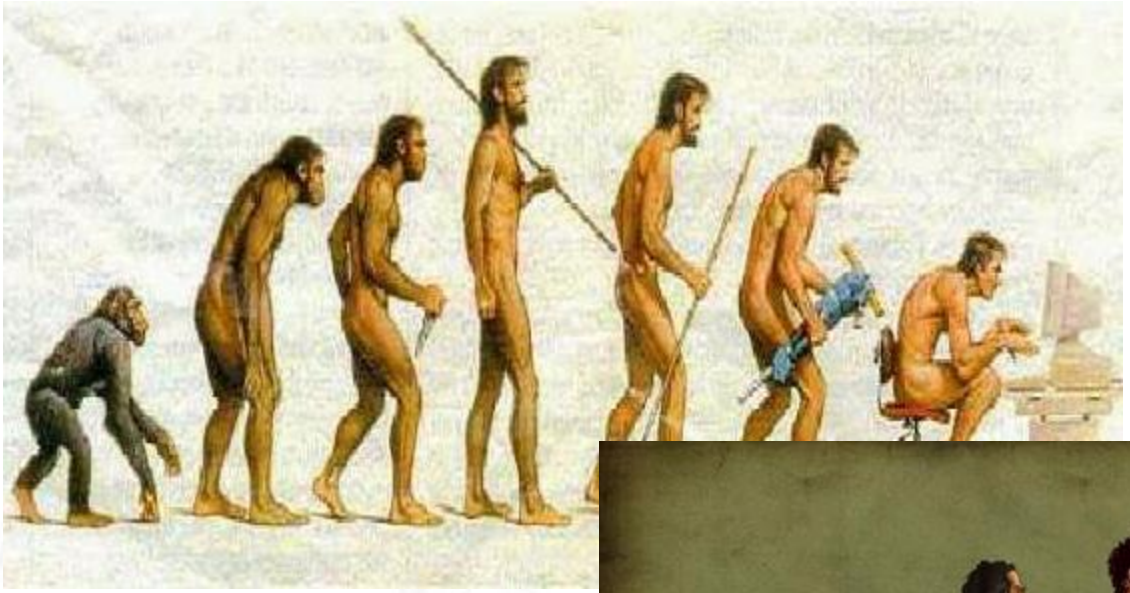
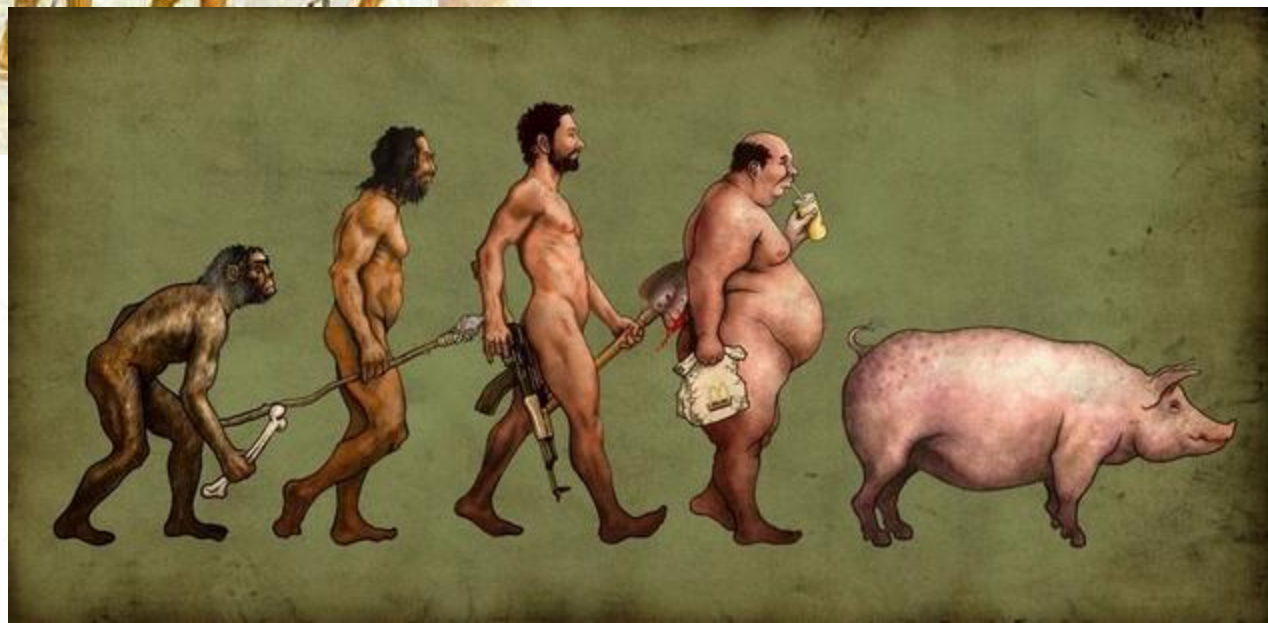
SMART MATERIALS: Engineered Self-Healing Materials

Bart Wallaeys

Mensdom

- Het duurde lang voor het mens'dom' slim werd





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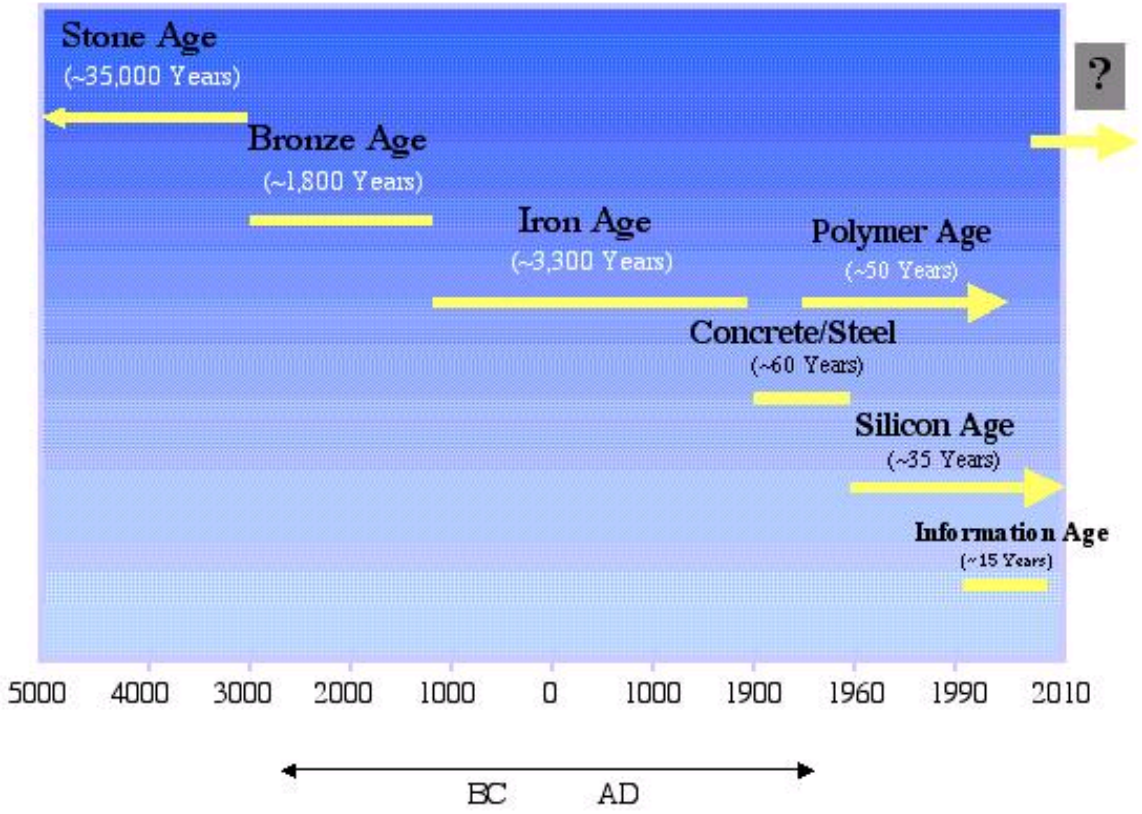
Materiaal evolutie

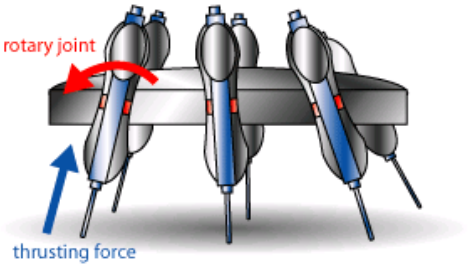
- Ook materiaal evolutie duurde lang

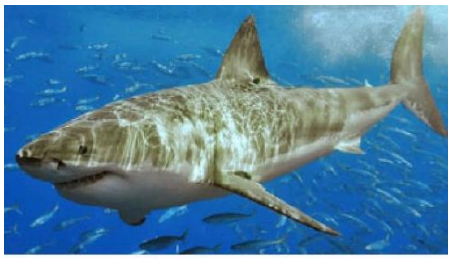


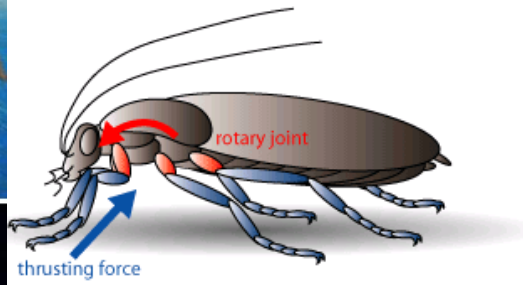
Graphic courtesy of Cornell University

biomimetica

- Veel te leren uit evolutie
- Recente wetenschap
- “the science and art of emulating Nature’s best biological ideas to solve human problems”

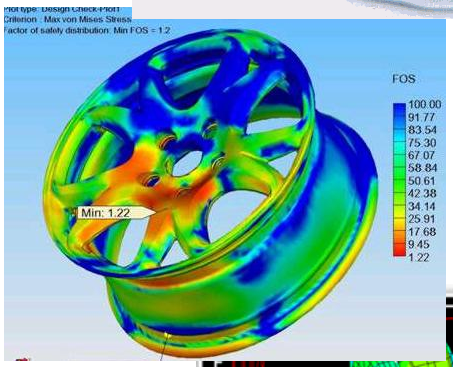


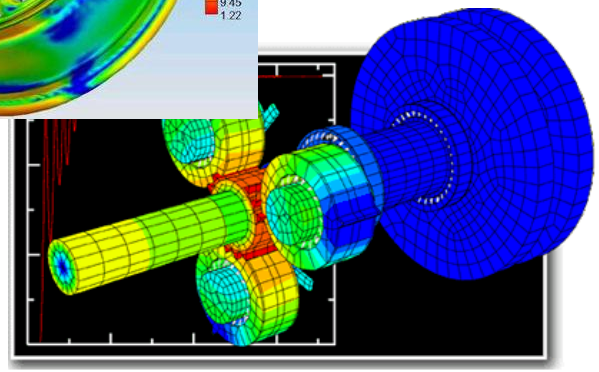




Slim materiaal

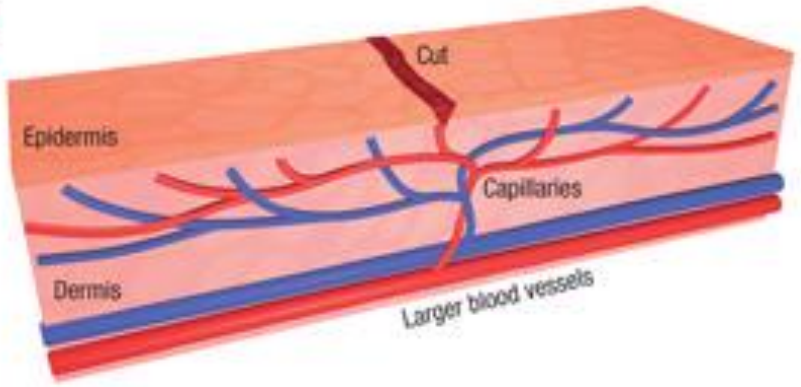
- ↔ dom materiaal
- Eigenschappen
  - Significant veranderen
  - Gecontroleerd
  - reversibel
  - Externe stimuli
- ↔ klassieke engineering
  - Materiaal designen/kiezen
  - Weerstaan aan “krachten”





Zelf-herstellend

- Natuur : niet ge-designed om aan alles te weerstaan
- In geval een ‘fout’ ontstaat :
  - Vroege & autonome detectie
  - ‘massale’ & efficiente actie
  - “Na” minstens even sterk dan “voor”
  - ‘onuitputtelijk’
  - goedkoop



materiaalontwikkeling

- Time to act

SIM

- Strategisch Initiatief Materialen
- Initiatief Vlaamse regering

SIM is **a platform to finance and direct joint strategic research** by universities and companies for the research areas

- "materials for energy & light",
- "durable & sustainable structural materials" and
- "tailored nanomaterials in their environment".

UNIVERSITEIT GENT

Universiteit Antwerpen

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deVan Chemicals

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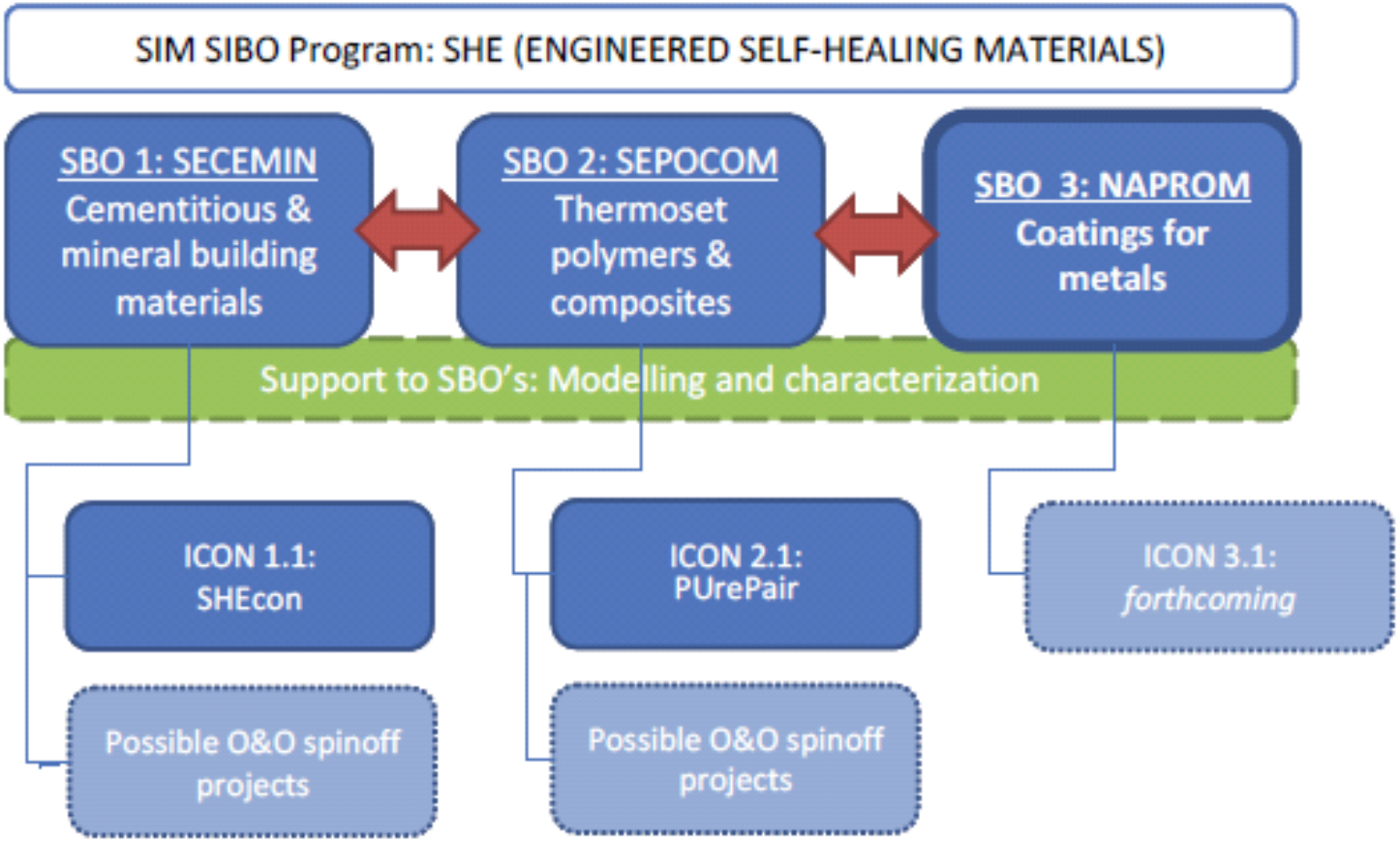
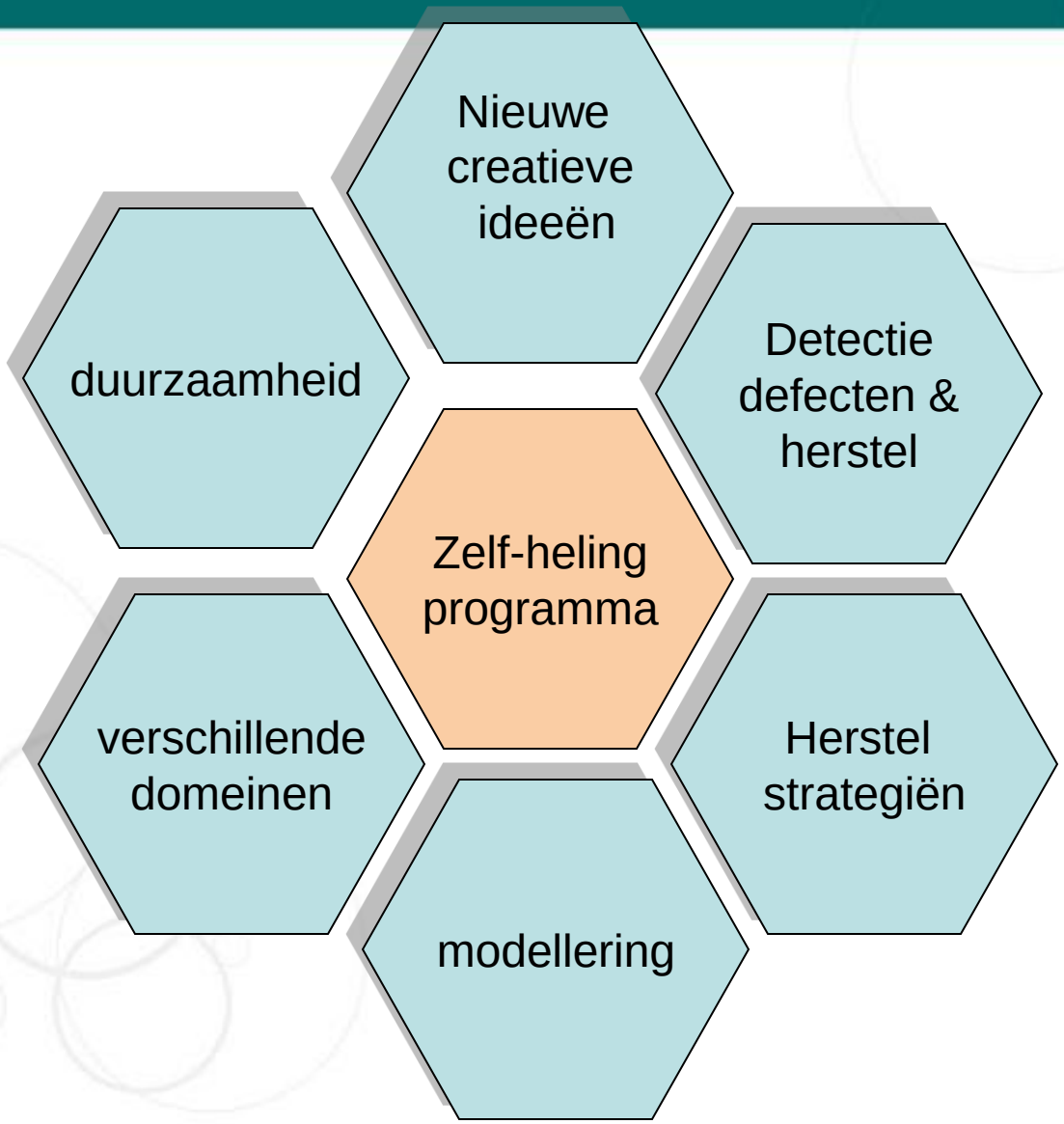
Het zelfherstellend programma

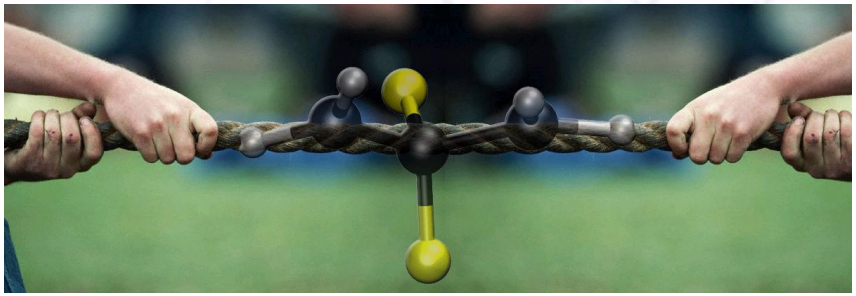


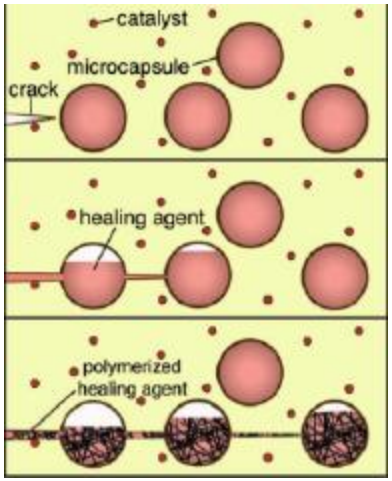
programma

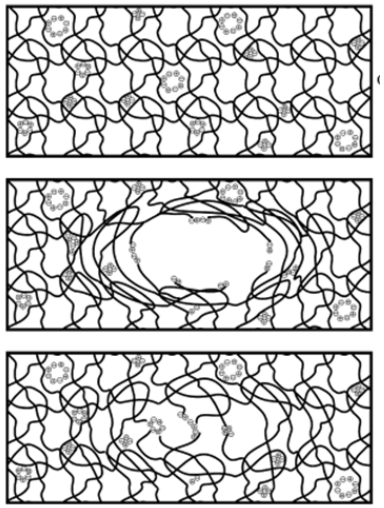

Nieuwe creatieve ideeën
duurzaamheid
Detectie defecten & herstel
Zelf-heling programma
verschillende domeinen
Herstel strategiën
modellering

herstelstrategie

- Autonomie/snelheid
  - Niet Autonoom
    - Externe trigger (zon, ..)
  - Autonoom
  - multistep
- Methodiek voor zelfherstel
  - Chemie
    - Reversiebele verbindingen
    - Plastische vervormingen, vorm geheugen materialen
    - Encapsulatie van reagentia
    - …
  - Bacteriën
  - ….

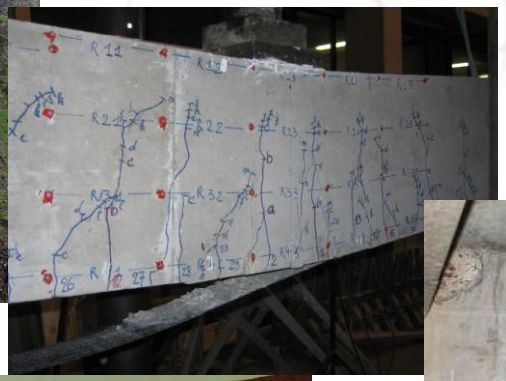


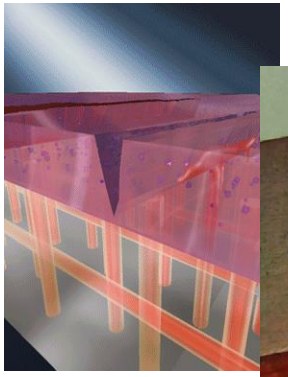
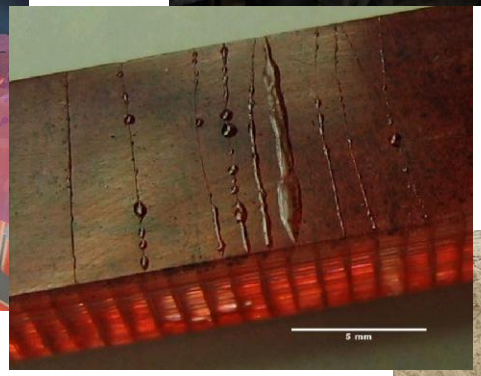




domeinen

- Beton
- Kunststoffen
- coatings

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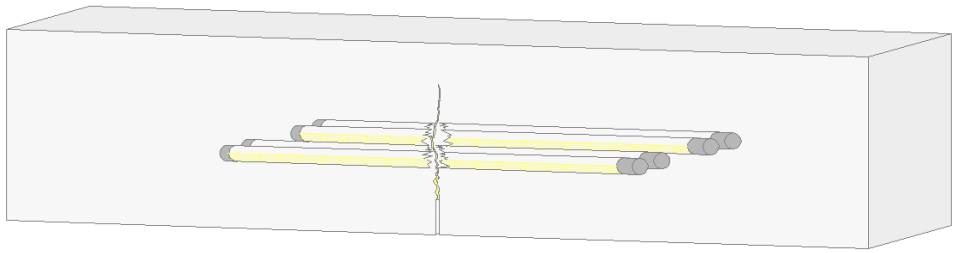
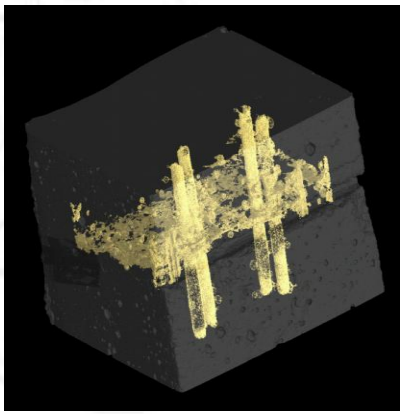
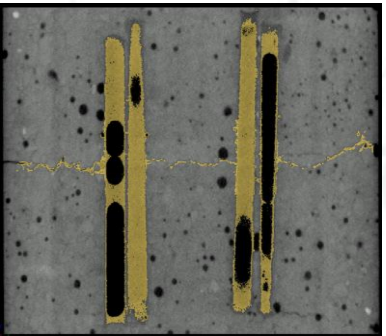
- Polyurethaan als herstel
- 2 componenten :
  - Prepolymer van PU
  - Accelerator & H_2O
- Glas of keramische buisjes (∅ 2-3mm)

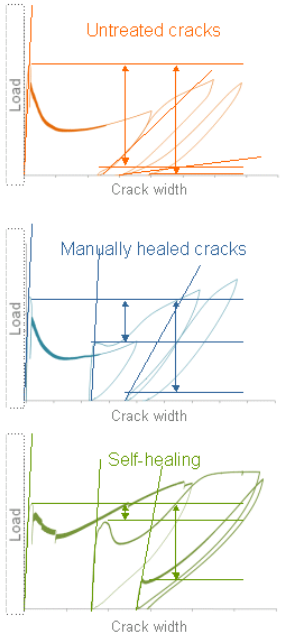


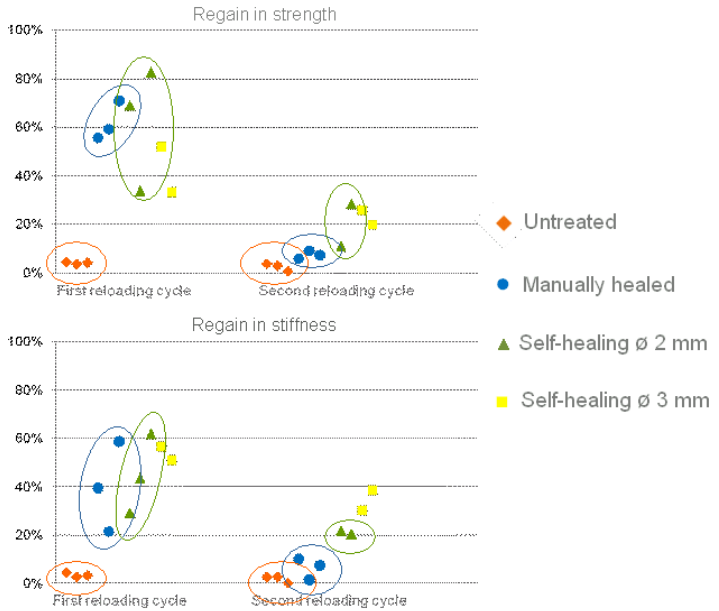
- Cracks veroorzaken
- PU zelf heling
- Sterkte/stijfheid
- waterpermeabiliteit



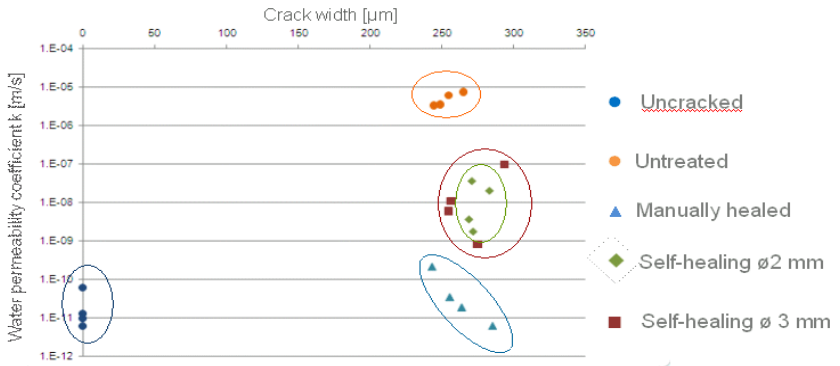


Regain in mechanical properties due to crack healing



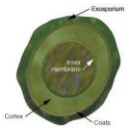


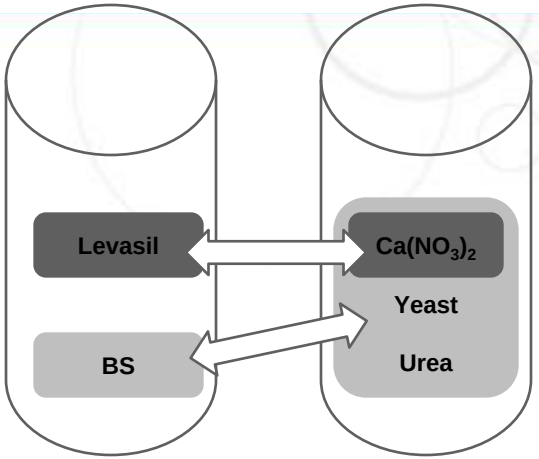
Decrease in water permeability due to crack healing

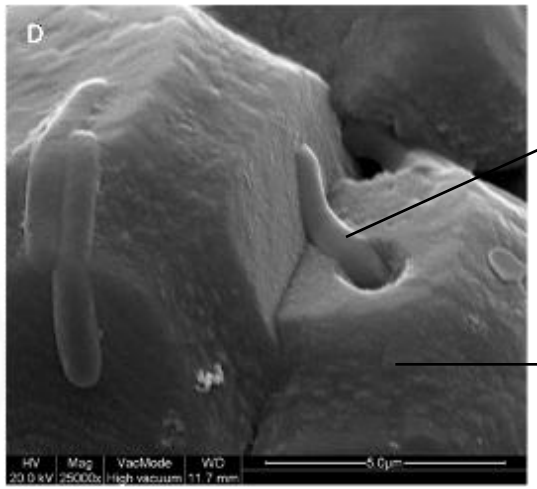


Water permeability is 100 to 10000 times lower, compared to untreated cracks, when self-healing properties are provided

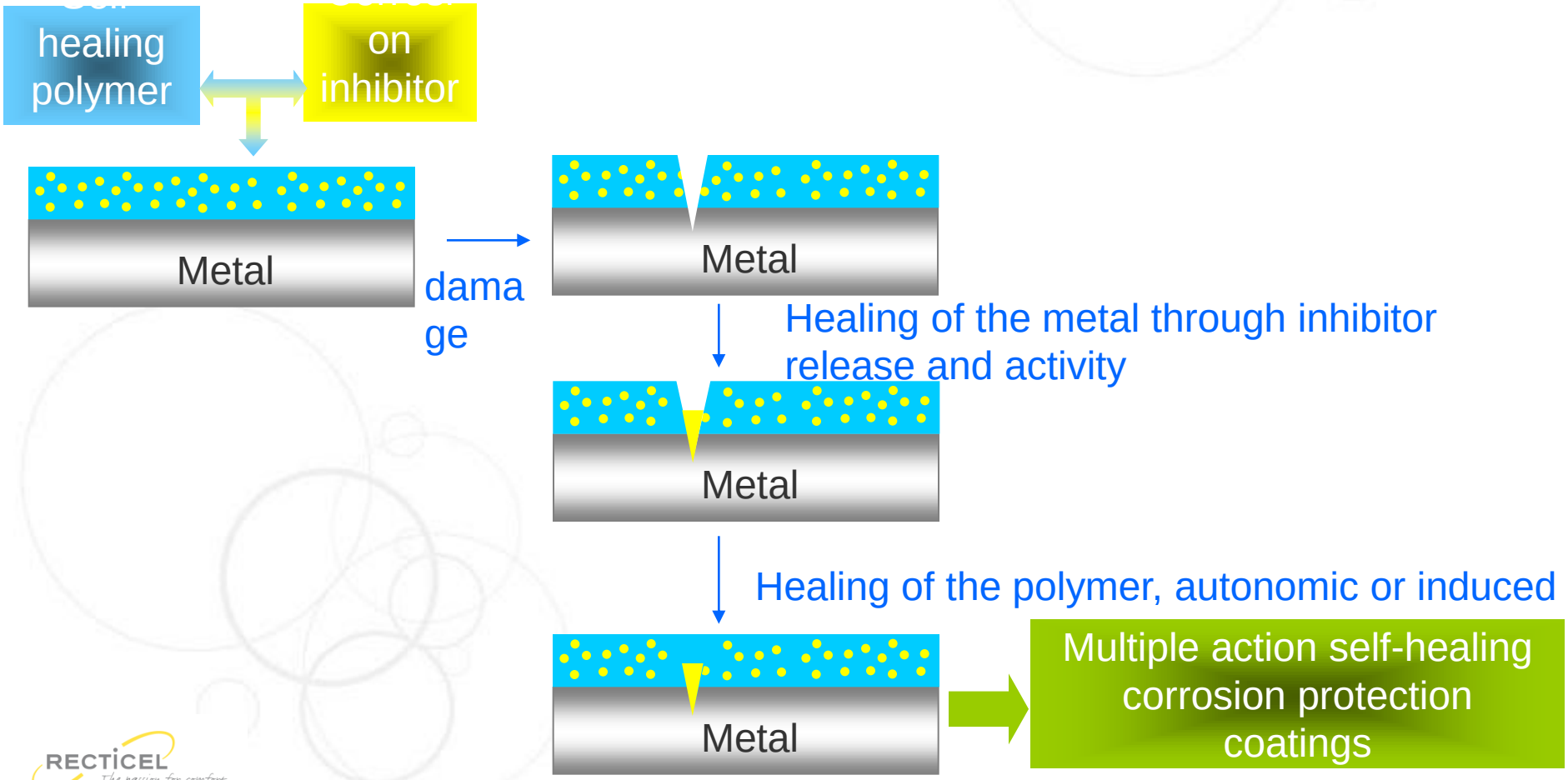
- Bacterieel
- Het recept :
  - Bacteria die $CaCO_3$ kristallen neerslaan
  - Ca bron
  - Voeding
  - Bescherming
    - Medium (sol/gel silica, PU)
    - Poreuze drager
  - Trigger mechanisme





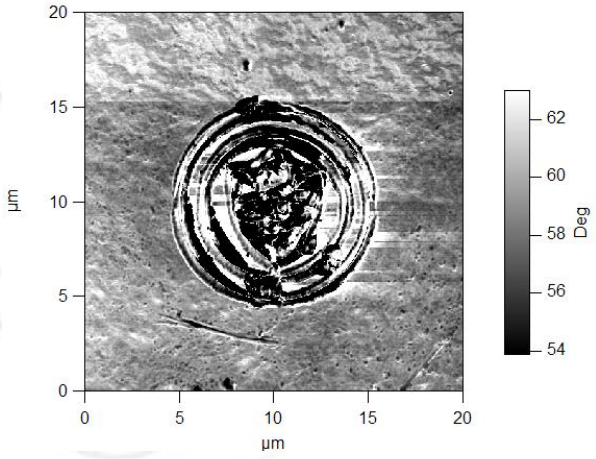


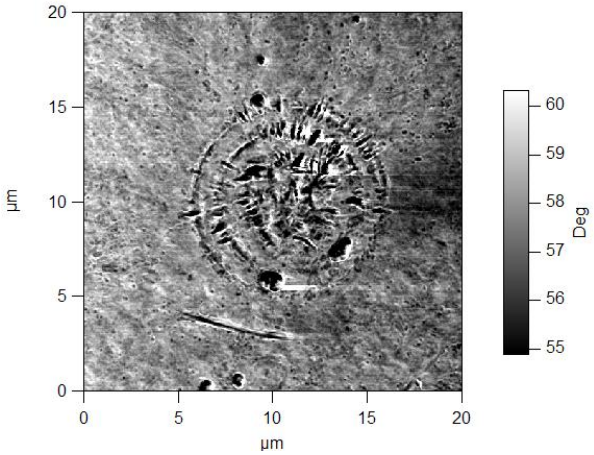
Concept van multiple actie zelfherstellende coating



duurzaamheid

- Gebruik grondstoffen
- Lichter
- Energie
- Levensduur





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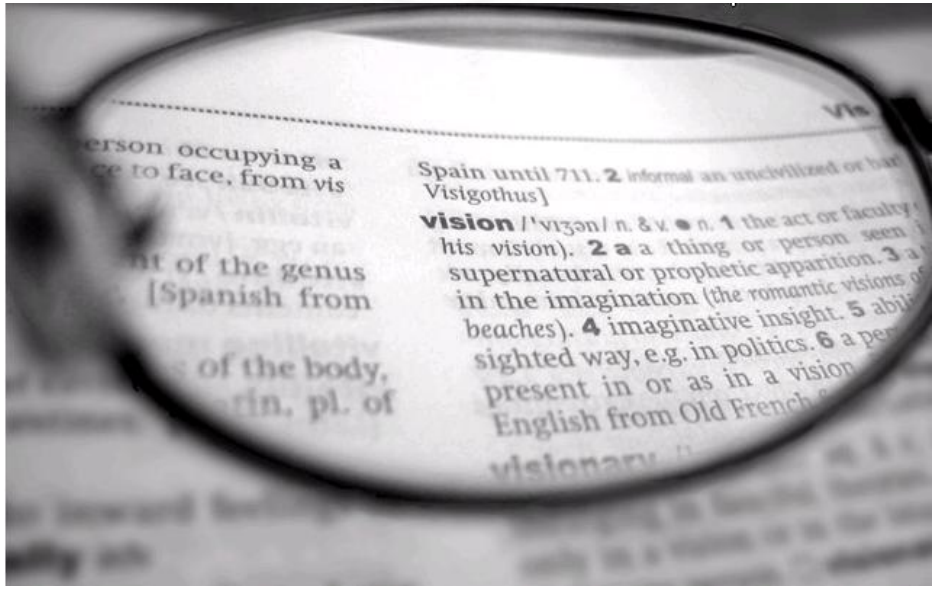
Zelf herstellend programma

- Open innovatie
- Breed programma
- SBO's & O&O projecten diverse bedrijven
- Zelf-herstellende materialen als toekomstvisie voor Vlaanderen



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“The future belongs to those who see possibilities before they become obvious”