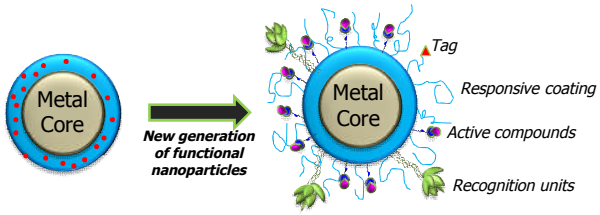
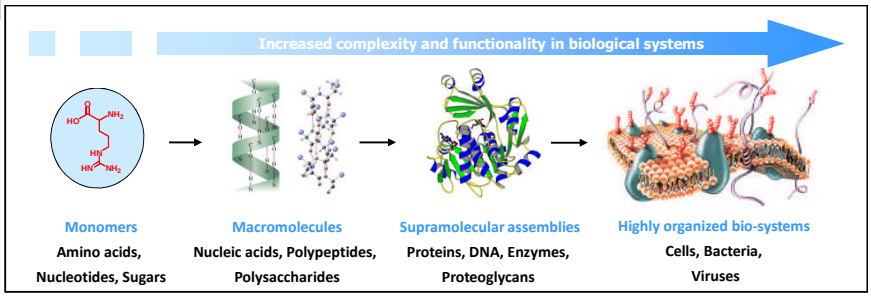
Research background and collaboration possibilities

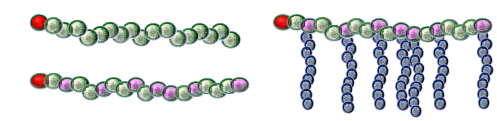
-Responsive & magnetic nanomedicines

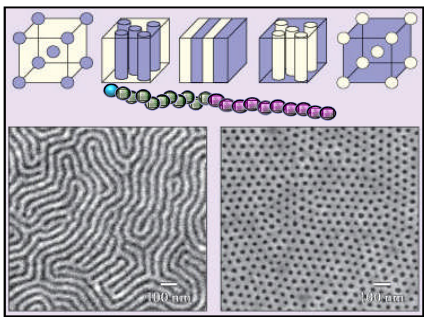


Dr. C. Remzi Becer
Department of Chemistry
University of Warwick
c.r.becer@warwick.ac.uk
www.warwick.ac.uk/go/remzi

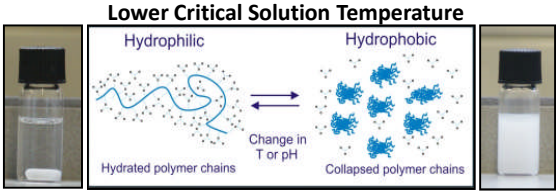
Smart polymers in our life



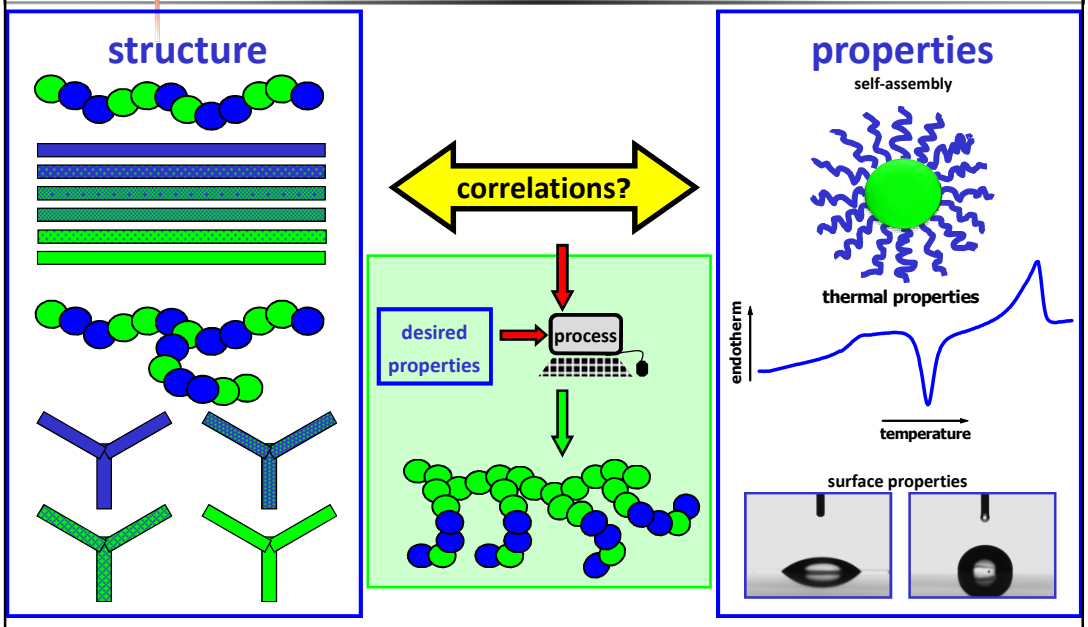




Lower Critical Solution Temperature

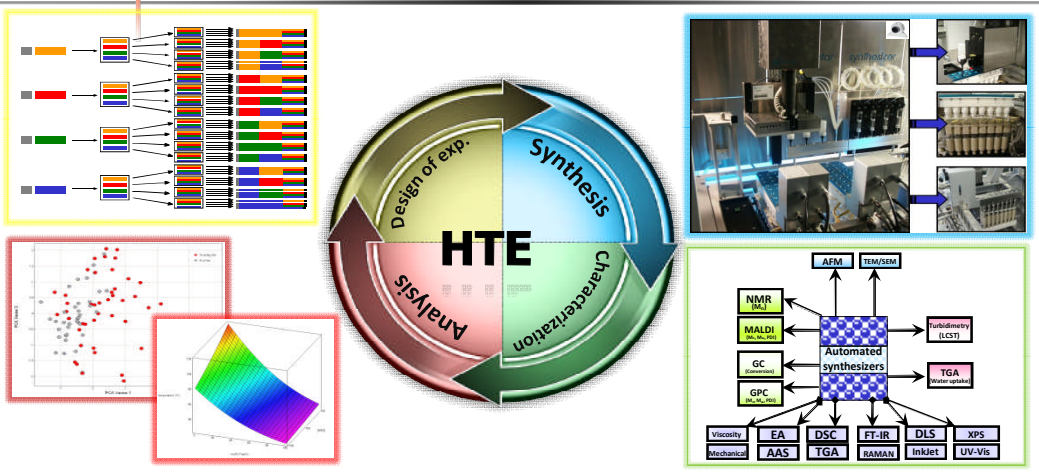


Structure-property relationship



→ Systematical (co)polymer libraries to elucidate structure-property relationships

High-throughput experimentation



Parameters & selections

Technique Controlled radical polymerizations, Living ionic polymerizations, "Click" reactions...

Monomer Styrenics, acrylates, methacrylates, acrylamides, methacrylamides...

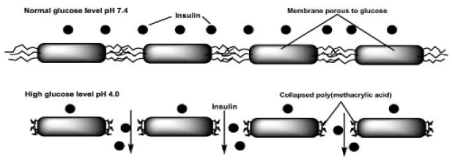
Initiator Free radical initiators, alkoxyamines, heterofunctional initiators, tosylates, a-bromo esters...

Catalyst Dithioesters, trithioesters, free-nitroxides nitrogen-based ligands...

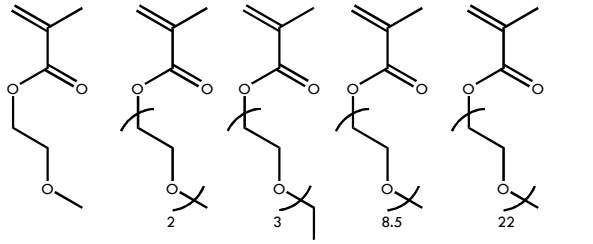
Solvent Aqueous sytems, organic solvents

J. Polym. Sci. Part A: Polym. Chem. **2006**, *44*, 6202-6213; *QSAR Comb. Sci.* **2008**, *27*, 978-983; *Adv. Polym. Sci.* **2009**, *225*, 17-62.

Smart polymer applications



pH-responsive membranes



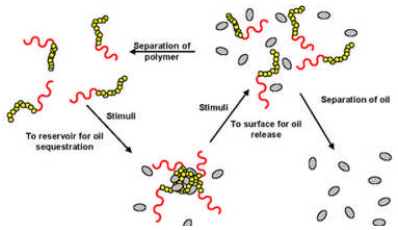
MEOMA — mono(ethylene glycol) methacrylate

MEO_2MA — di(ethylene glycol) methacrylate

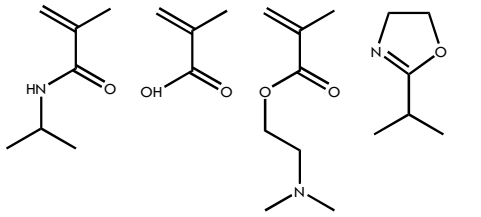
$OEGEMA_{246}$ — tri(ethylene glycol) ethyl ether methacrylate

$OEGMA_{475}$ — oligo(ethylene glycol) methacrylate

$OEGMA_{1100}$ — oligo(ethylene glycol) methacrylate



Encapsulation and separation technology



NIPAM — *N*-isopropyl acrylamide

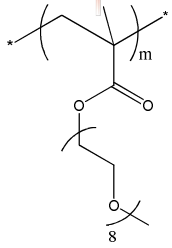
MAA — Methacrylic acid

DMAEMA — *N,N*-dimethyl acrylamide

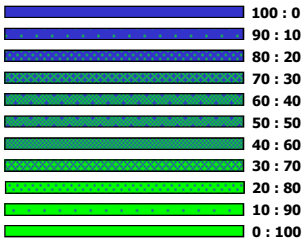
i-PrOx — 2-*iso*-propyl-2-oxazoline

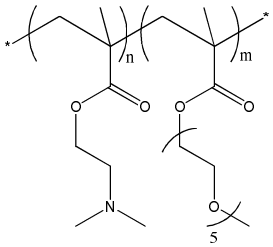
Macromolecules **2008**, *41*, 5132; *J. Polym. Sci. Part A: Polym. Chem.* **2008**, *46*, 7138; *Macromolecules* **2009**, *42*, 2965; **2010**, *43*, 160.

Responsive polymer libraries

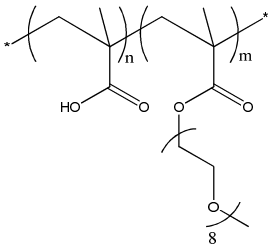


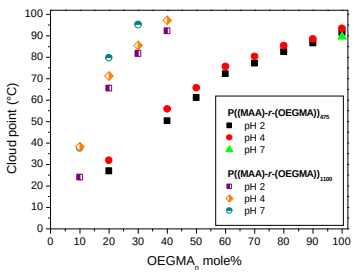
$P(OEGMA)_8$
thermo responsive
homopolymer library



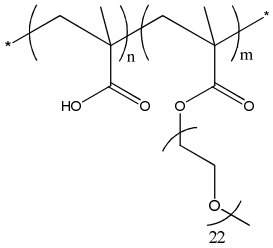


$P(DMAEMA)$-*r*-$P(OEGMA)_5$
pH and thermo responsive
copolymer library

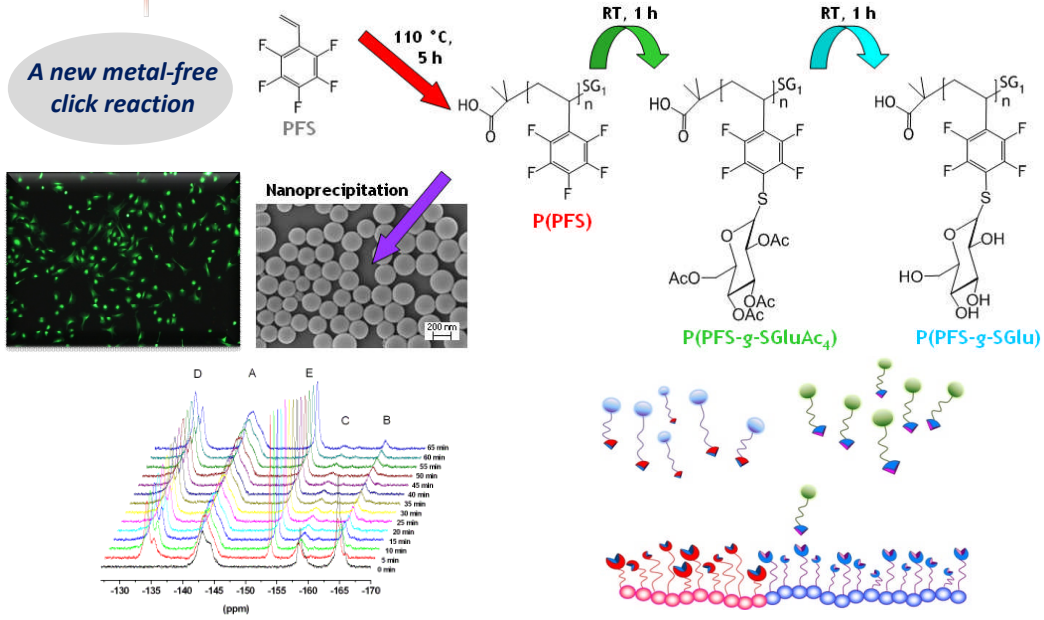




$P(MAA)$-*r*-$P(OEGMA)_{8\ or\ 22}$
pH and thermo responsive library

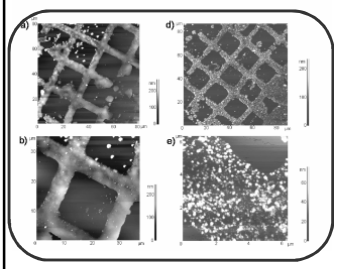


Tailor-made macromolecules

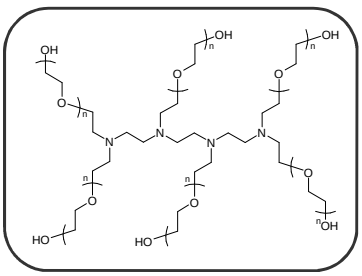


Angew. Chem. Int. Ed. **2009**, *48*, 4900; *Macromolecules* **2009**, *42*, 2387; *J. Polym. Sci. Part A: Polym. Chem.* **2010**, *48*, 1278.

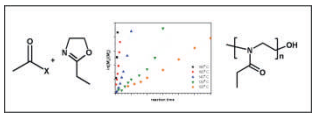
Other projects during my PhD research



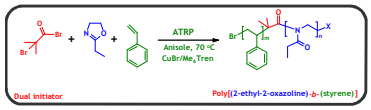
Small **2007**, *3*, 220



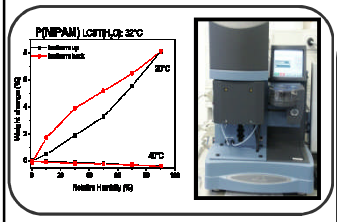
Macromol. Rapid. Commun. **2007**, *28*, 1161



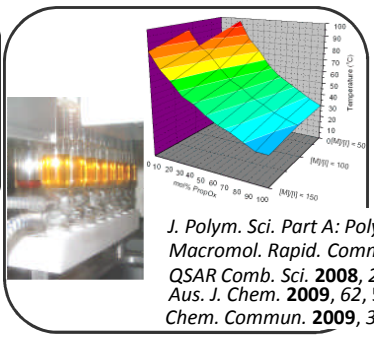
Macromol. Chem. Phys. **2008**, *209*, 794



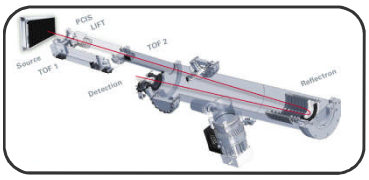
Macromolecules **2008**, *41*, 5210



J. Mater. Chem. **2007**, *17*, 4864

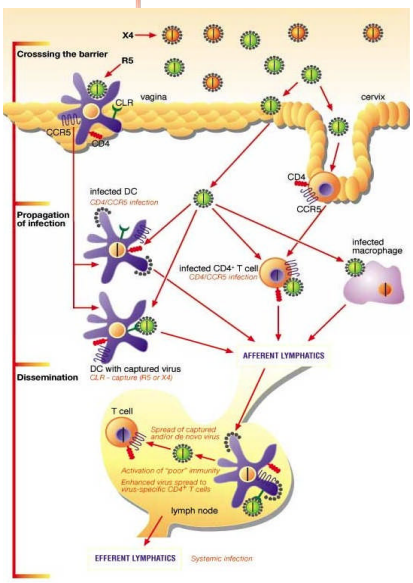


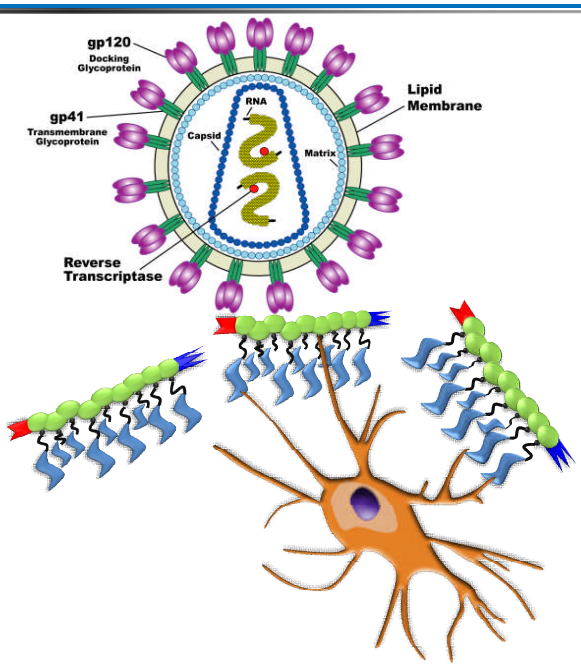
J. Polym. Sci. Part A: Polym. Chem. **2006**, *44*, 6202.
Macromol. Rapid. Commun. **2007**, *28*, 484; **2008**, *29*, 1919
QSAR Comb. Sci. **2008**, *27*, 977
Aus. J. Chem. **2009**, *62*, 58; **2009**, *62*, 254.
Chem. Commun. **2009**, *37*, 5882



Macromol. Rapid. Commun. **2008**, *29*, 130

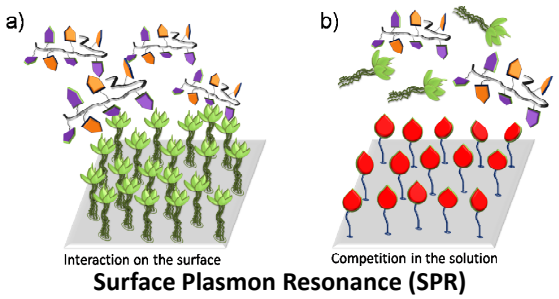
Inhibition of HIV binding to DC-SIGN



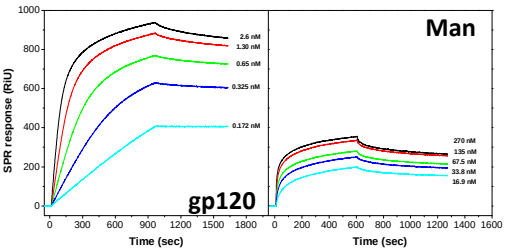


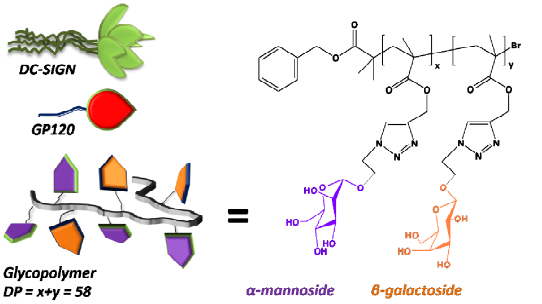
Dendritic Cell

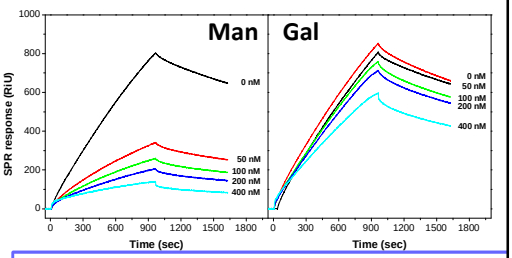
Glycopolymers to inhibit HIV Infection?



Surface Plasmon Resonance (SPR)







37 nM of mannose glycopolymer inhibits the binding of gp120 by 50%.

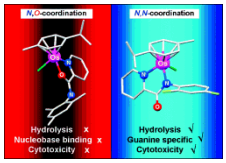
in collaboration with Warwick Medical School (Dr. Daniel Mitchell)

J. Am. Chem. Soc. 2010, 132, 15130-15132.

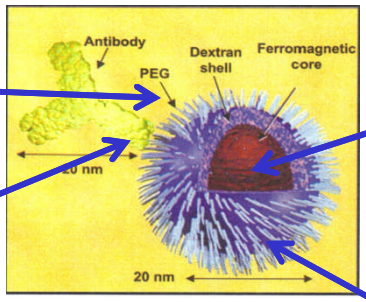
Aim of the proposed research

Stimuli responsive
(Thermo, pH, ion)
(well-defined smart polymers)

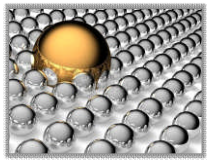
Active compounds
(anti-cancer drugs)
Prof. Sadler (Warwick)
Dr. Snaith (Birmingham)

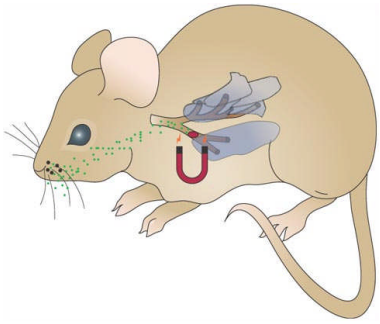


Clinical trials
(reduced toxicity)
Dr. Mitchell (Warwick)
Dr. Gibson (Warwick)

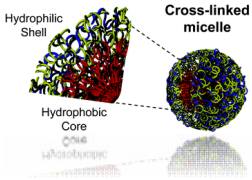


Magnetic core
Dr. Wright (Birmingham)





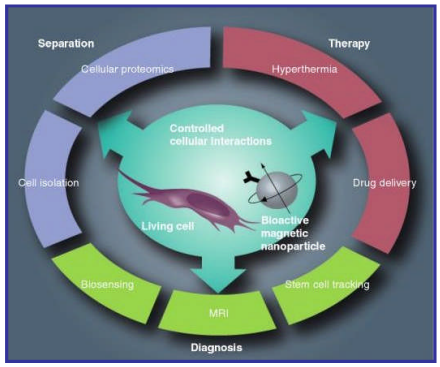
Biorecognition units
(metallo-glycopolymers)
Dr. O'Reilly and Prof. Haddleton



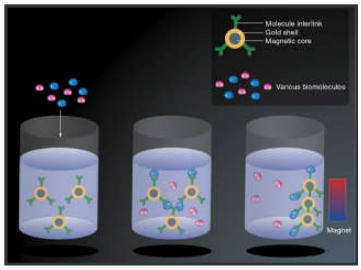
http://www.nist.gov/cnst/epg/nanomag.cfm

Applications and funding

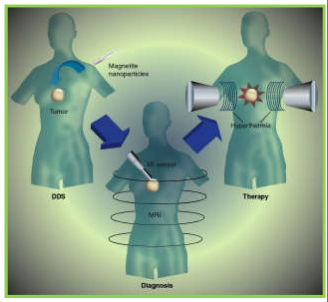
"EuroNanoMed's first call for proposals focused on the three main subfields of nanomedicine: diagnostics, targeted delivery, and regenerative medicine. A second call will be launched in 2010. The two calls have a joint budget of between EUR 40 million and EUR 60 million…" *from EU-ERA*



"The nanotechnology budget under FP7 is €3.5 billion, and around €100 million per year is expected to be allocated to projects in the field of nanomedicine." *from CORDIS news, EU*



"(*Nanowerk News*) The Supervisory Council of RUSNANO has approved a project to produce nanodrugs with targeted delivery for treatment of malignant neoplasms. Total budget for the project is 3.9 billion rubles of which RUSNANO will invest 1.299 billion rubles." *from Russia*



Collaboration possibilities

- Synthesis of catalysts, initiators and monomers for living radical polymerizations.
- High-throughput experimentation. Libraries of desired monomers or polymers.
- Structure-property relationships of copolymers. *immediately*

- Series of functional nanoparticles for various applications. *soon..*

- Further characterization techniques.
  - XPS, Mass spec, microscopy (AFM, SEM and TEM), Particle analyzers, and Biological tests.
- Modelling, structure-property analysis of the nanoparticle libraries. *will need*

Acknowledgement

DPI DUTCH POLYMER INSTITUTE

TU/e Technische Universiteit Eindhoven University of Technology Where innovation starts

NWO

Fonds der Chemischen Industrie

seit 1558

FREISTAAT THÜRINGEN Kultusministerium

SEVENTH FRAMEWORK PROGRAMME

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