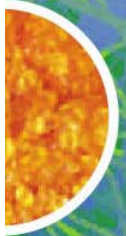
INGENIERIE DES MATERIAUX POLYMERES

Chemistry of Polymers

by

Etienne Fleury, Philippe Chaumont and Mohamed Taha



This document is an overview (PDF from PPT presentation)

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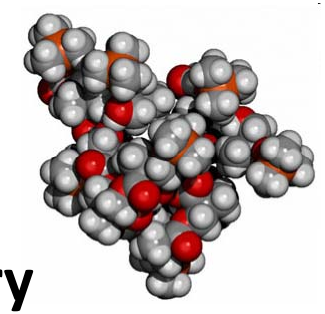
Unité Mixte de Recherche 5223

CHEMISTRY OF POLYMERS



OBJECTIVES

- To develop

  * basic research in macromolecular chemistry

  * Chemical tools in cooperation to the other lab. Activities (design of macromolecular architectures and morphologies for given functionality(ies))

- To integrate sustainability in research approaches

- To get innovative approaches for designing and functionalizing macromolecular architectures

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COMPETENCES

* Molecular Chemistry
* Chemical Modification of Polymers and Polysaccharides
* Chemistry of Polymerization
    - Polycondensation / Polyaddition
        => PU, Polyepoxy, Polyamide, Polyester…,
    - Ring-Opening Polymerization
        => Lactides, Glycolides, Cyclosiloxane..,
    - Radical Polymerization
        => Free-radical, NMP, RAFT, ATRP
* Polymerization Processes (dispersed media, High T°, Sol Gel, SC CO_2,…)
* Chemical and Microstructure Analysis

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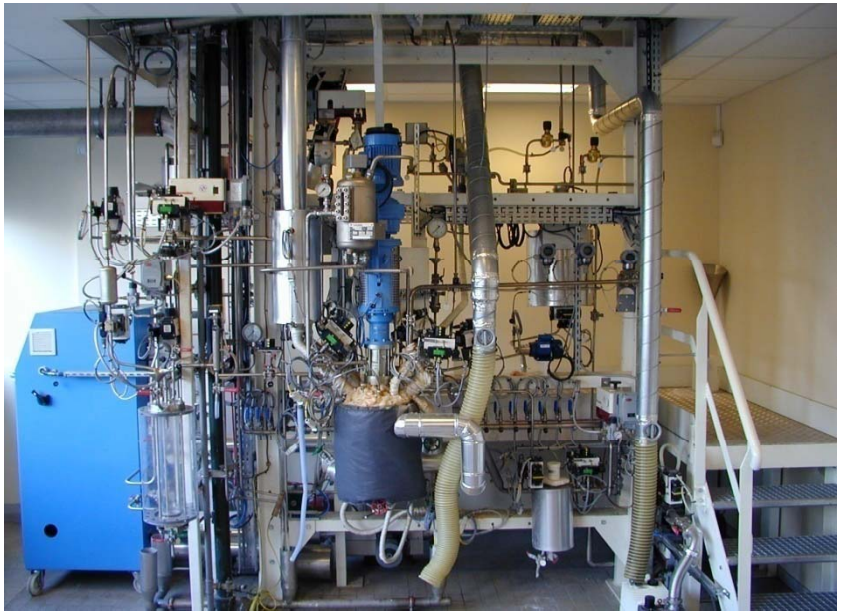
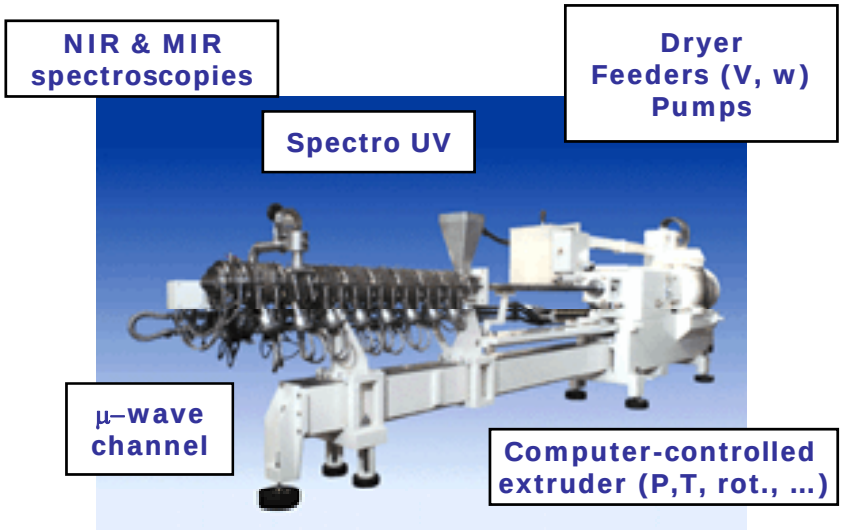
SPECIFIC TOOLS

Pilot reactor for polyesters synthesis (8.5L, 290°C, 7bars)



Pilot reactor for polyamides synthesis (1L, 350°C, 50 bars)



CHEMISTRY OF POLYMERS

TOPICS

TOPIC #I : Molecular & Macromolecular Engineering

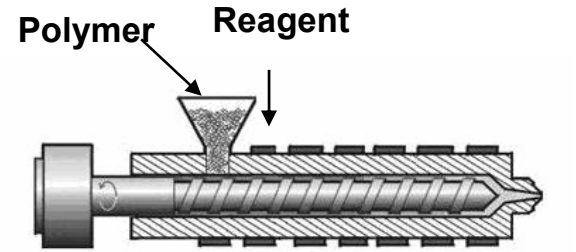
- **I.1 Macromolecular Engineering in Molten State**
- **I.2 Polymers with Controlled Architecture**
- **I.3 « New » (macro)molecular Chemistry from Soft Conditions and/or Selective and/or Reversible Reactions**

TOPIC #II : Chemistry & Sustainable Development

- **II.1 Chemistry for Reactive Extrusion**
- **II.2 Non Toxic Processes**
- **II.3 Biosourced Polymers**
- **II.4 Modification of polysaccharides**

TOPI #III : Surfaces & Interfaces Chemistries

- **III.1 Synthesis of Nano-objects**
- **III.2 Functionalization of Planar Surfaces**
- **III.3 Functionalization of Fillers**



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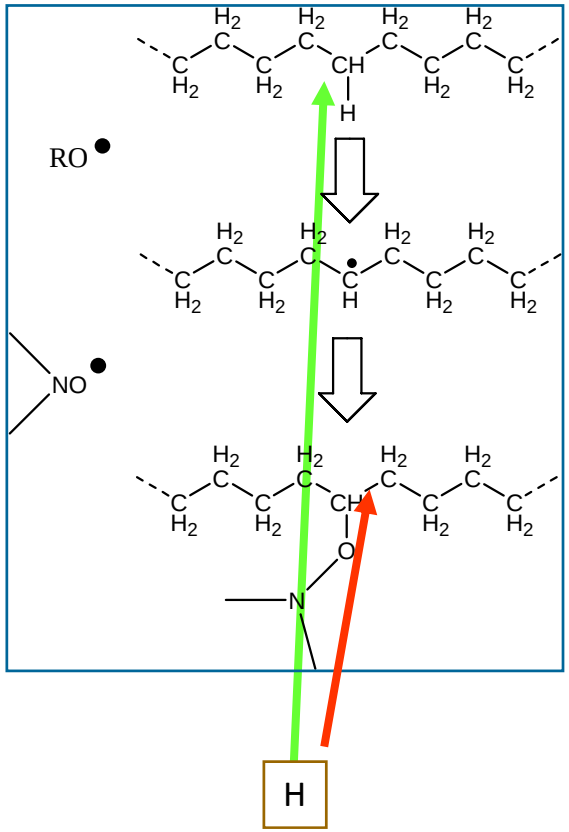
TOPIC #I : Molecular & Macromolecular Engineering

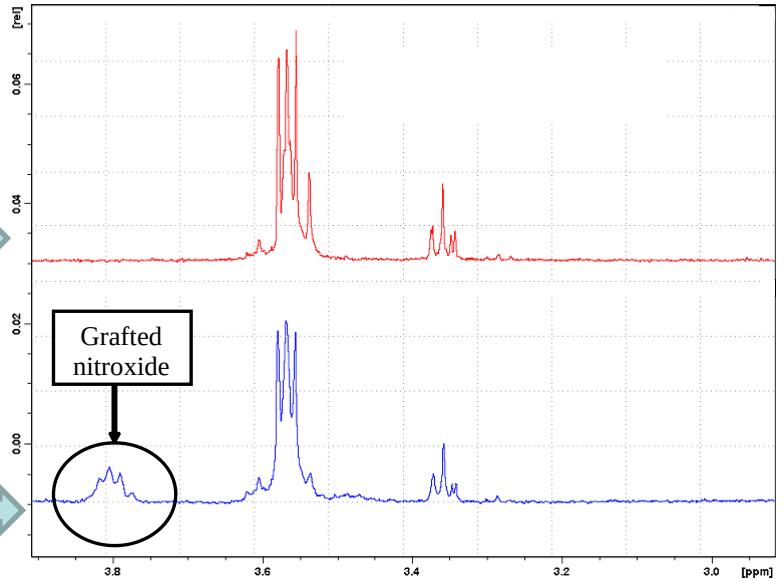
I.1 Macromolecular Engineering in Molten State

LDPE + peroxide



without TEMPO

with TEMPO



- Badel T., Beyou E., Bounor-Legare V., Chaumont P. Flat J.J., Michel A.
J. of Polym. Sci. Part A (2007) 5215-5226
- Ibid Macromolecular Material and Engineering (2012)
- Akbar S., Beyou E., Chaumont P., Mazzolini J., Espinosa E., D'Agosto F., Boisson C.
J. of Polym. Sci. Part A (2011) 957-965

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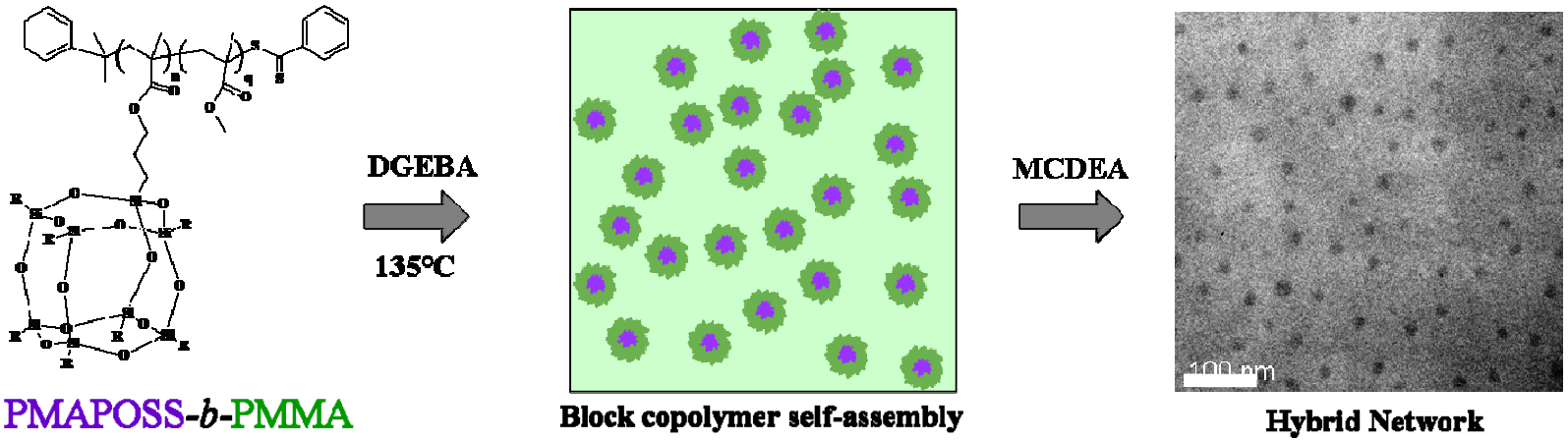
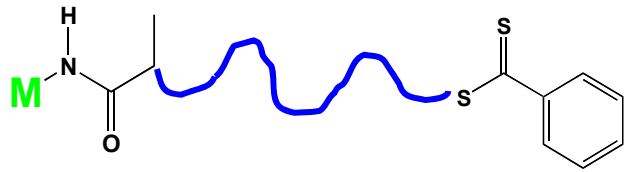
TOPIC #I : Molecular & Macromolecular Engineering

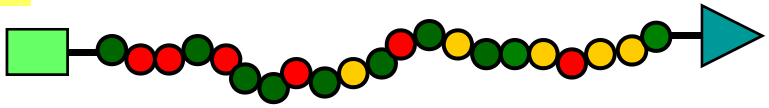
I.2 Polymers with Controlled Architecture

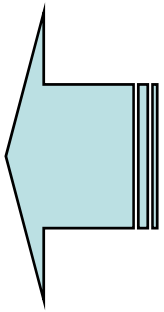


Deng Y., Bernard J., Alcouffe P., Galy J., Dai L., Gérard J. F. J. of Polym. Sci. Part A-Polymer Chemistry (2011) 4343-4352

M-NH_2 = Biological derivatives







Probes for bio-imaging

Fonction 1	Fonction 2	Fonction 3	Fonction 4

Charreyre M.T. et al. JACS 2006, Macromol. Rapid. Commun 2007, WO 2007/003782

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TOPIC #I : Molecular & Macromolecular Engineering

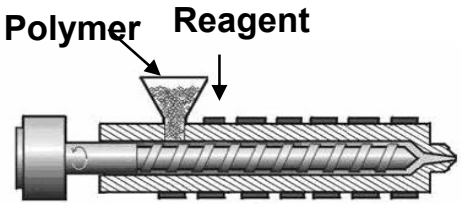
I.3 « New » (macro)molecular Chemistry from Soft Conditions and/or Selective and/or Reversible Reactions

"Click Chemistry" : Sharpless et al. 2001 =>
chemio-selectivity, robusteness, atom economy,…

- **1,3-dipolar cycloaddition (Huisgen)**
- **Radical addition thiol-ene**
- **Dipolar Cycloaddition [4+2] (Diels Alder)**
- **Oximes / hydrazones**
- **…**

Binauld S., Damiron D., Hawker C. J., Connal L. A., Drockenmuller E. Macromolecular Rapid Communications (2011) 147-168

Magana, S., Zerroukhi, A., Jegat, C., Mignard, N. Reactive & Functional Polymers (2010) 70, 442-448



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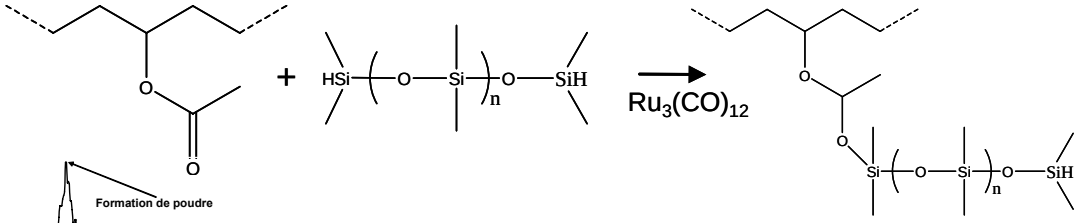
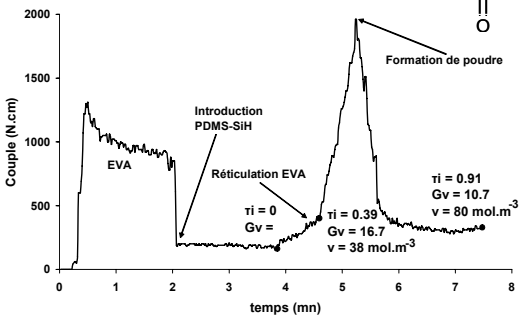
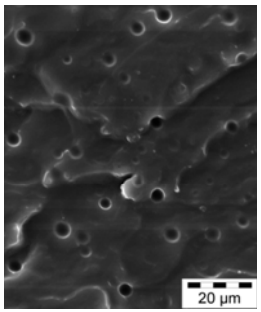
TOPIC #II : Chemistry & Sustainable Development

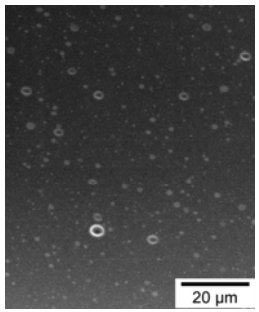
II.1 Chemistry for Reactive Extrusion







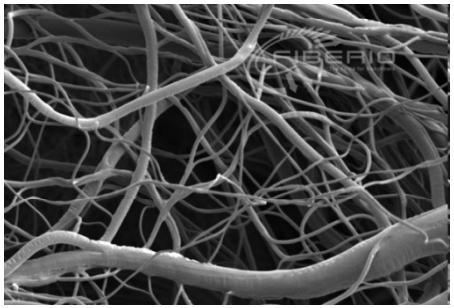
Non reactive blend EVA/PDMS-SiH



Reactive Blend EVA/PDMS-SiH

Bonnet J., Bounor-Legaré V., Boisson F., Mélis F., Cassagnau P.
J. of Polym. Sci. Part A- (2011) 2899-2907

Starch



Polyesters
=> PC, PG, PLA

Zhao Y., Becquart F., Chalamet Y., Chen J., Taha M.
Macromol. Mater. Eng. (2009) 651-657

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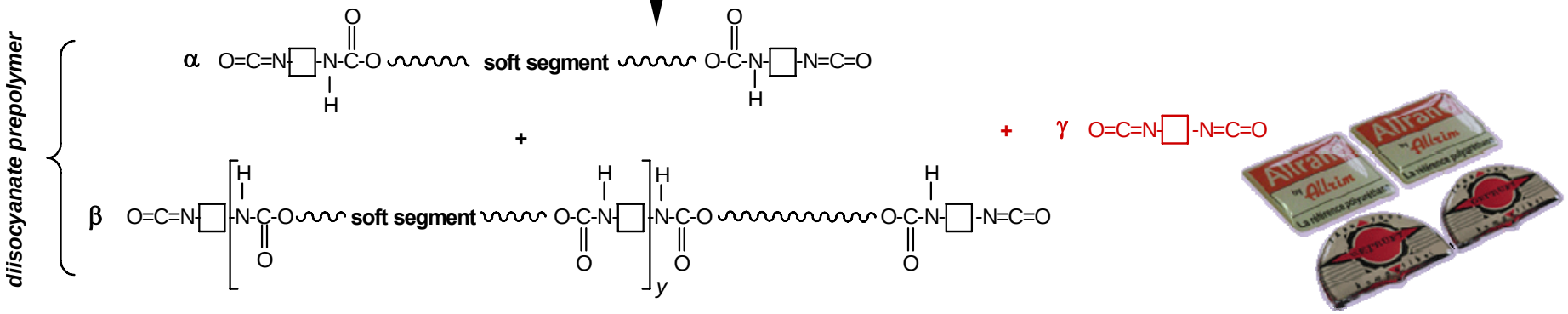
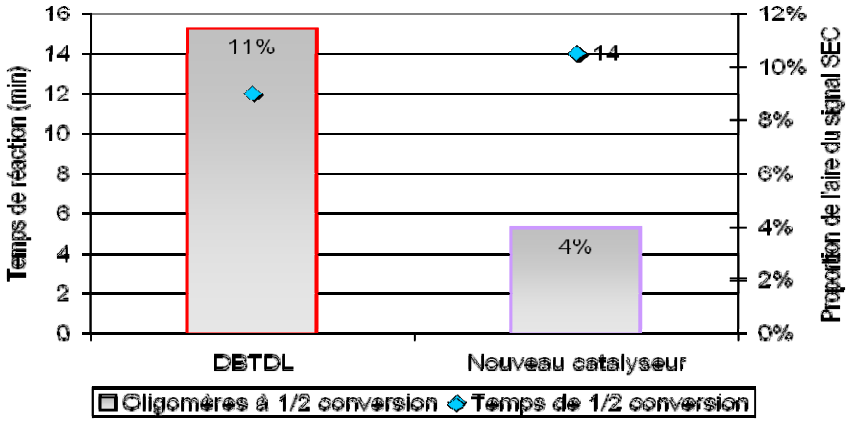
TOPIC #II : Chemistry & Sustainable Development

II.2 Non Toxic Processes



- Residual monomers

- Catalysts



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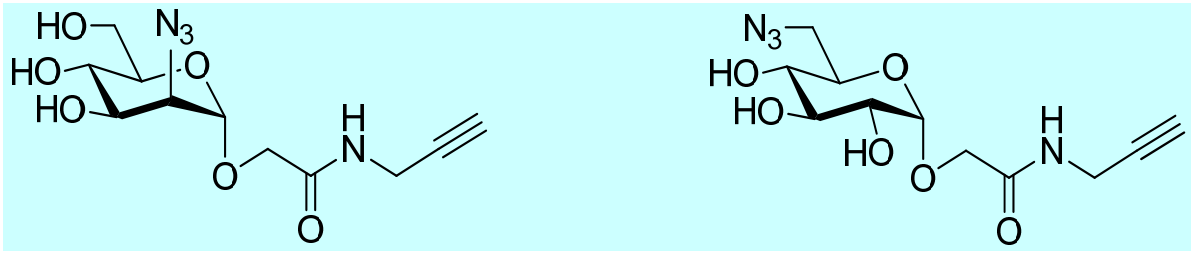
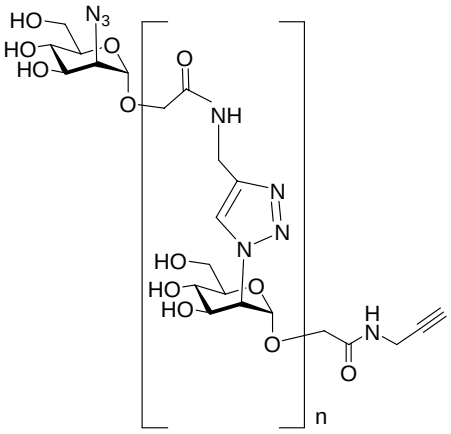
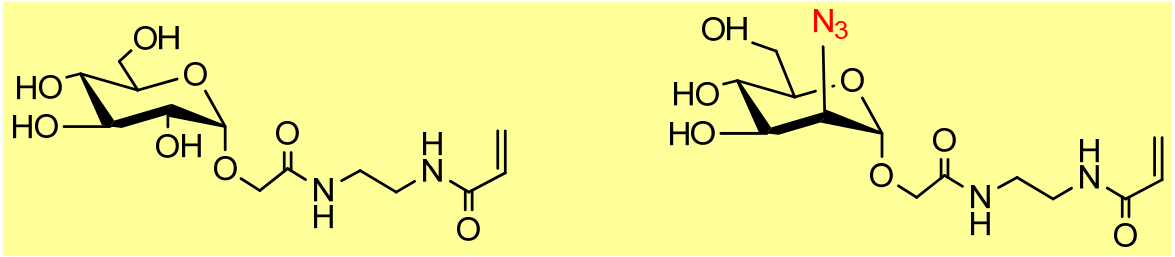
TOPIC #II : Chemistry & Sustainable Development

II.3 Biosourced Polymers

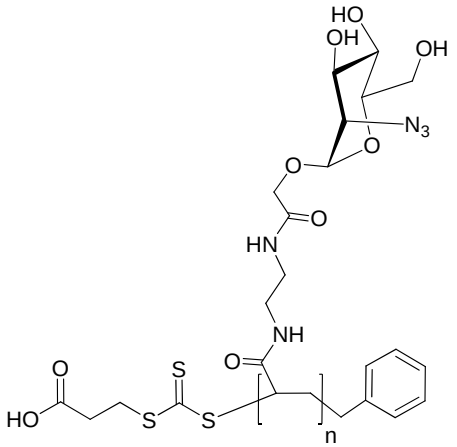


J. Chen, S. Chambert, J. Bernard, E. Fleury, Y. Queneau,
Sci. China Chem, 2010, *53*, 1880-1887.





Abdelkader, S. Moebs, J. Bernard, Y. Queneau, E. Fleury,
J. Polym. Sci. Pol. Chem. 2011, *49*, 1309-1318



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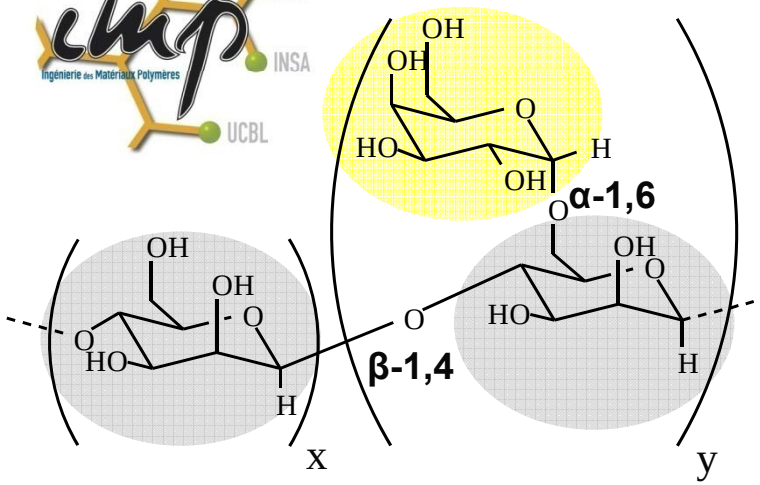
TOPIC #II : Chemistry & Sustainable Development

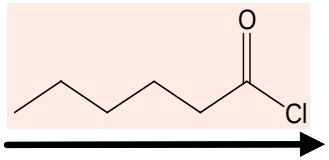
II.4 Modification of polysaccharides



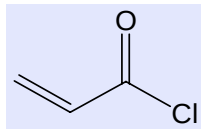
Galactomannan

Guar esterifications in ionic liquids

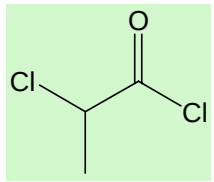
5 %
in BMIMCl



surfactant



macromonomer



ATRP macroinitiator

3 %
in H_2O

DS = 0.12

10 %
in $CHCl_3$

DS = 2.70

Chemical network

C. Lacroix, E. Sultan, E. Fleury, A. Charlot Polymer Chemistry 2012, 3, 538-546

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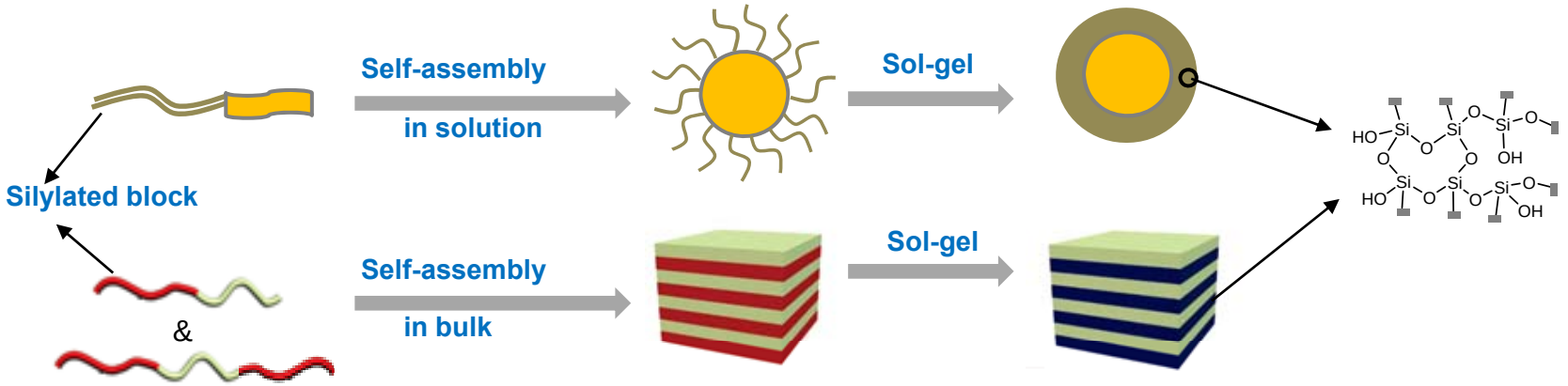
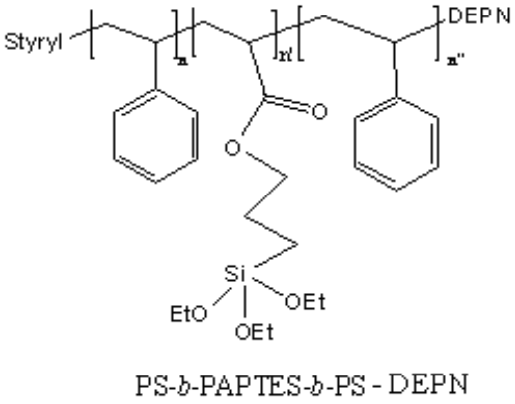
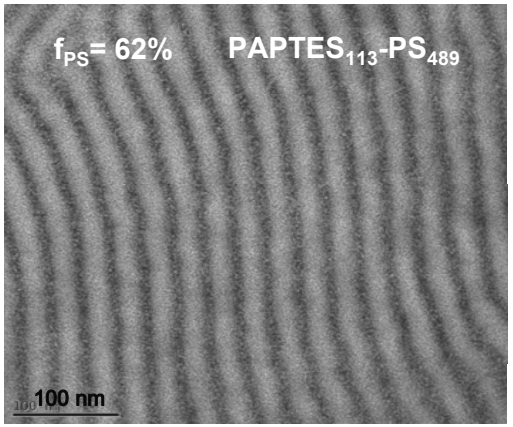
TOPIC #III : Surfaces & Interfaces Chemistries

III.1 Synthesis of Nano-objects



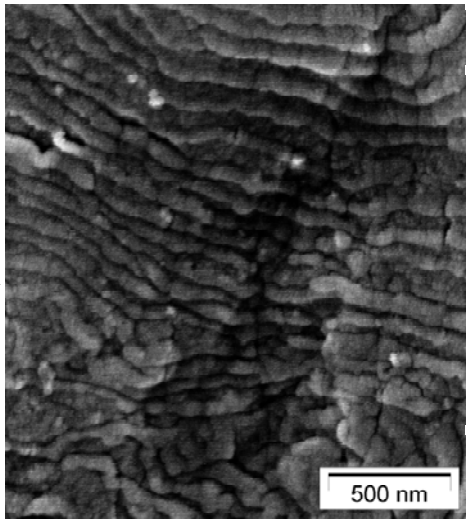


PS-*b*-PAPTES-*b*-PS - DEPN



1) HCl, 1M

2) Calcination
800°C



Beyou et al, cover page, J Polym Sci, Polym Chem. (2011) 4193-4203

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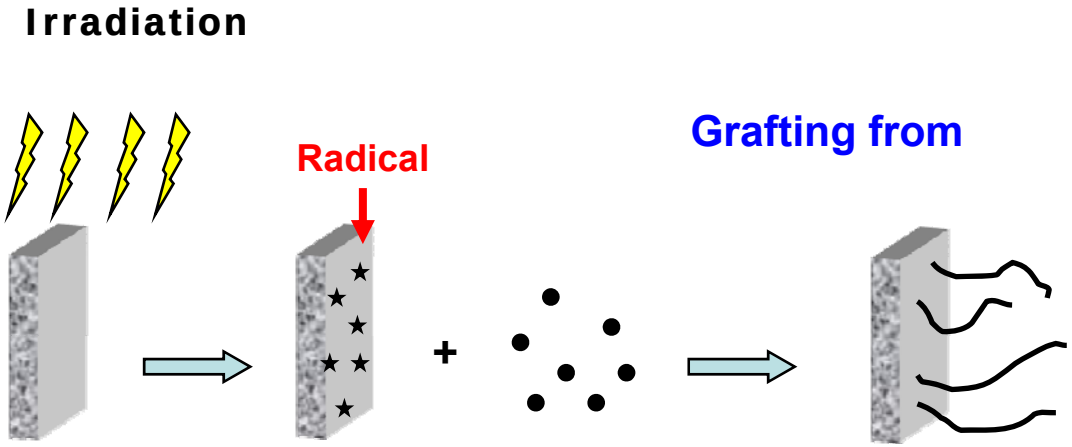
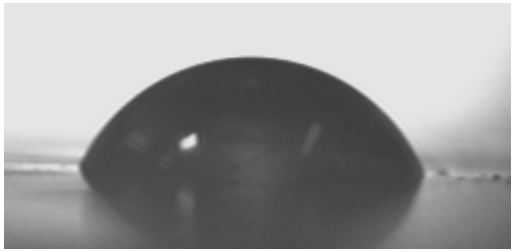
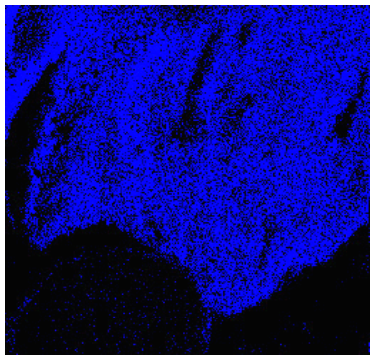
TOPIC #III : Surfaces & Interfaces Chemistries

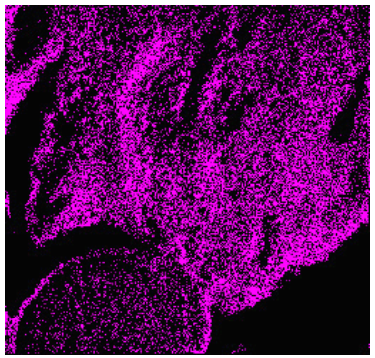
III.2 Functionalization of Planar Surfaces





Copolymer
(PVDF/PA 6-6)-*g*-PHEMA





^{19}F **(MEB/EDX)** ^{16}O

Fortin N., Albela B., Bonneviot L., Rouif S., Sanchez J.-Y., Portinha D., Fleury E. Radiation Physics and Chemistry (2011) 10.1016 /j.radphyschem.2011.10.027

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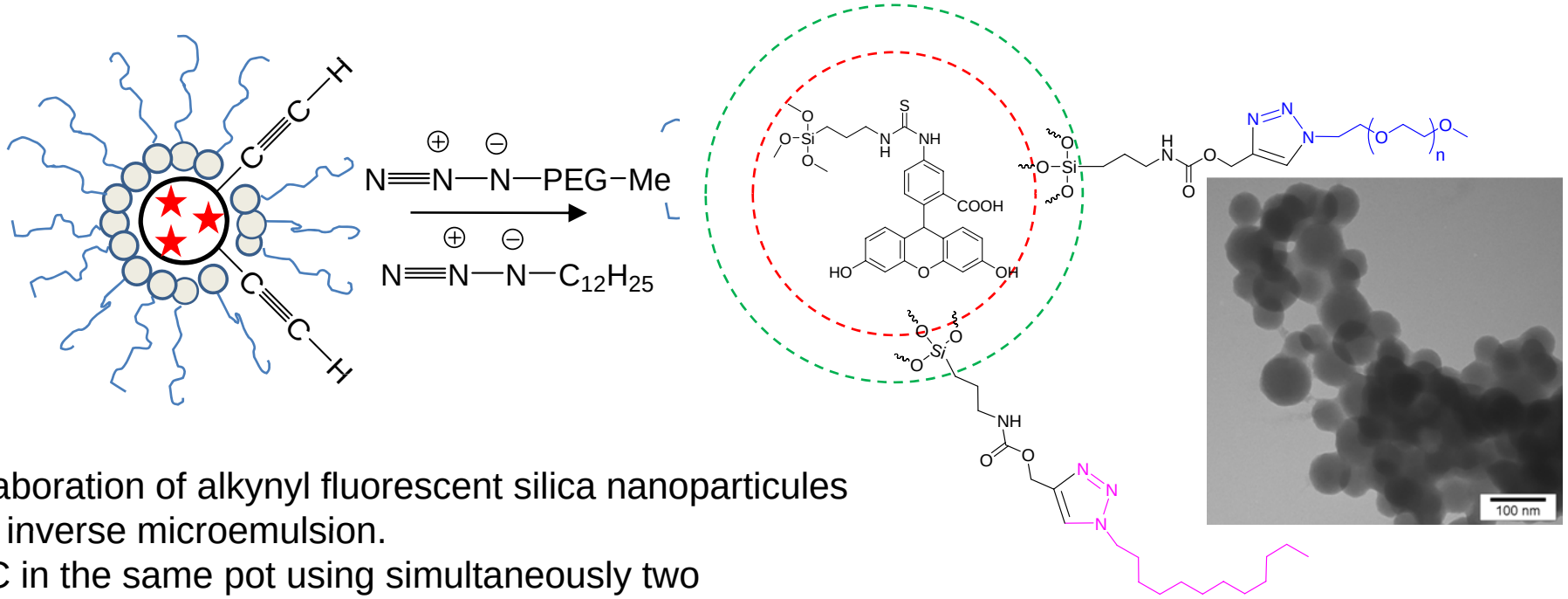
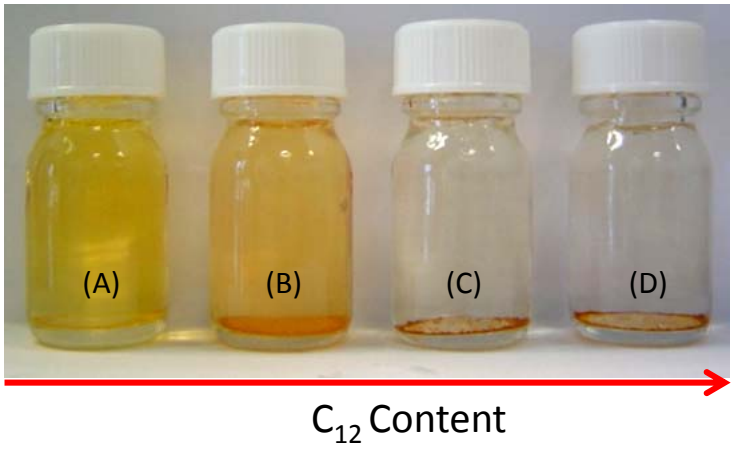
TOPIC #III : Surfaces & Interfaces Chemiseries

III.3 Functionalization of Fillers



Elaboration of alkynyl fluorescent silica nanoparticules by inverse microemulsion.
CC in the same pot using simultaneously two reactants of various HLB

Colloidal stabilization of mixed MEG-dodecyl silica nanoparticles in water.
MPEG:C_{12} = 100:0 (A); 75:25 (B); 50:50 (C); 25:75 (D)



C. Tissandier, O. Tillement, T. Hamaide. Langmuir 2012, 28 (1), 209-218

CHEMISTRY OF POLYMERS

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