

La chimie click, un couteau suisse au service de la santé et de l'environnement

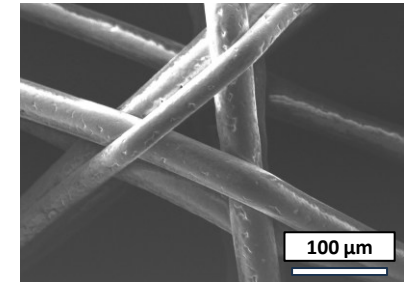
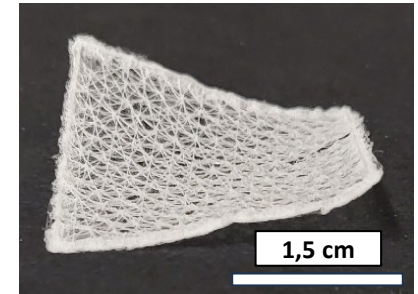
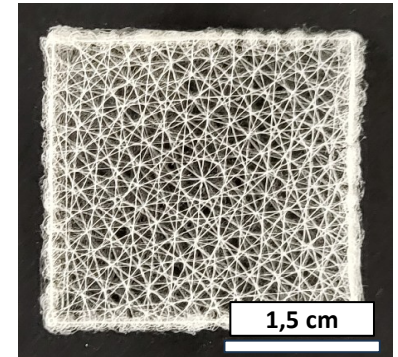
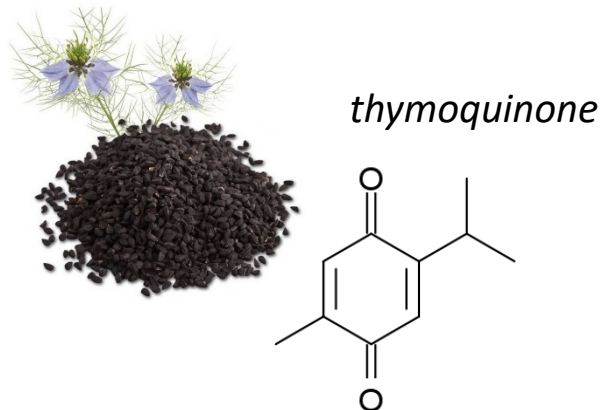
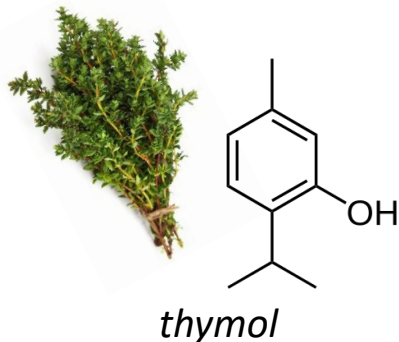
Séminaire Vichy – Pôle Santé & Environnement

7-8 janvier 2026

Matériaux pour l'ingénierie tissulaire

- Supporter la régénération des tissus biologiques (pansements, implants)
- Limiter les infections bactériennes → antibiotiques mais... **résistance bactérienne aux antimicrobiens** : 10 millions de morts en 2050*
- Composés phytochimiques : propriétés antibactériennes et faible potentiel de résistance.

*Naghavi, Mohsen, et al. "Global burden of bacterial antimicrobial resistance 1990–2021: a systematic analysis with forecasts to 2050." *The Lancet* 404.10459 (2024): 1199-1226..

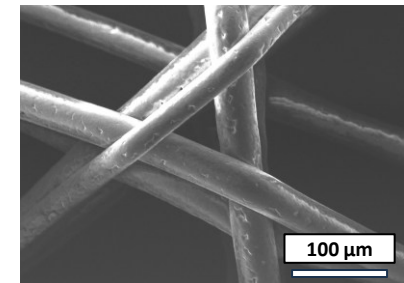
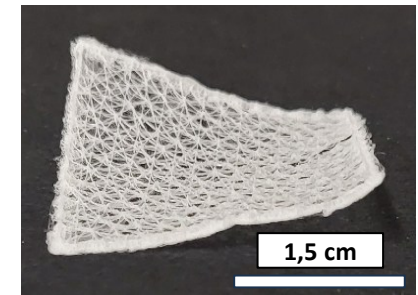
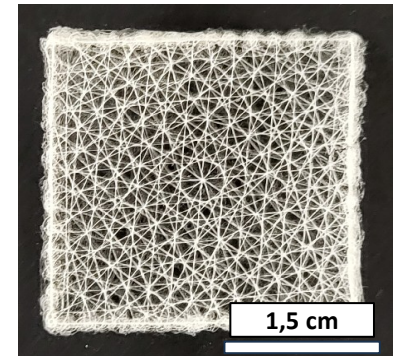


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Comment intégrer des composés phytochimiques dans nos biomatériaux afin de prévenir les infections tout en limitant l'antibiorésistance ?



Comment rendre ces matériaux modulables facilement ?

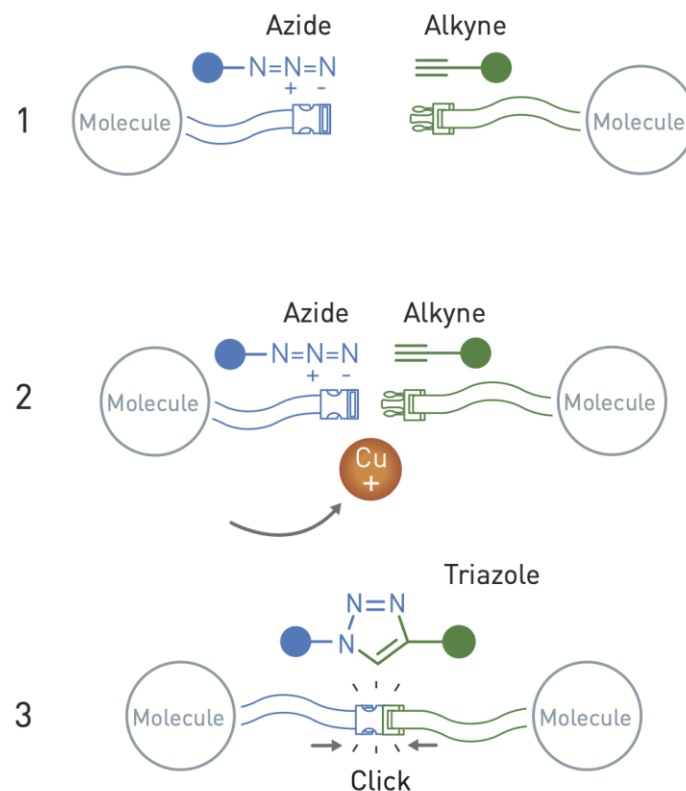
La chimie click : présentation



« Chimie click » permet des réactions :

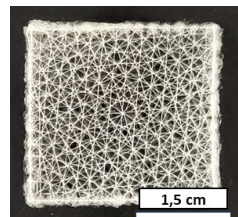
- Modulables
- Bon rendement
- Rapides
- Sélectives
- Conditions douces
- Peu de sous produits
- Compatible en milieu biologique

(réactions bio-orthogonales)

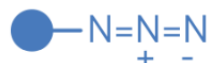


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Plateformes Cliquables



Active
molecules



PCL Membrane



Active molecules

Active molecules



PCL Membrane



PCL Membrane



Thiol

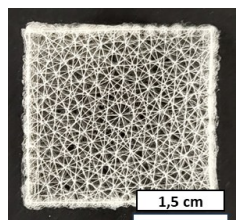


Active molecules

Alkyne or Alkene

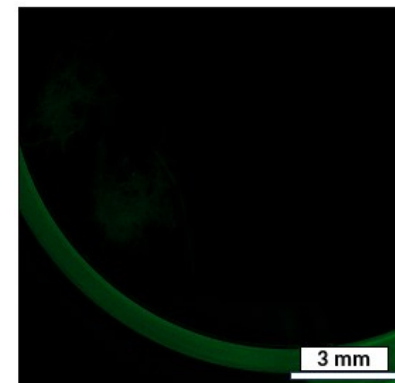
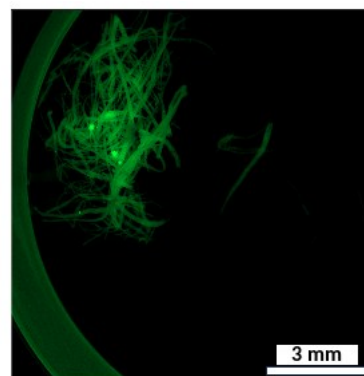
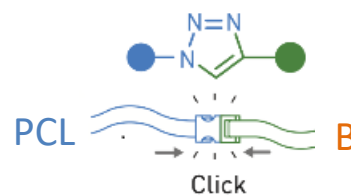
La chimie click : premiers résultats

Plateformes Cliquables



Active
molecules

Preuve de concept : click d'un fluorophore



Molécules actives

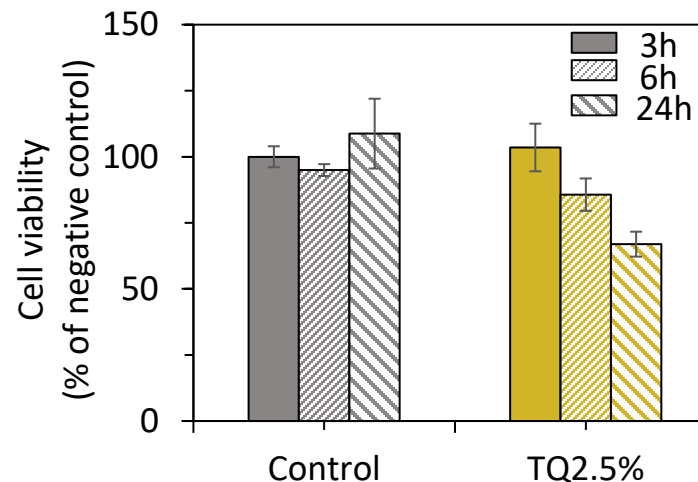
Application santé (thèse de A. Le Brun)

Application Environnement (captation de radionucléides - J. Lao)

Application santé (thèse de Aela Le Brun)

- Aspect Sciences des matériaux et chimie ✓
- Tester nos matériaux en biologie (culture bactérienne et **cellulaire**) – LMGE 1fois/an 😞

Cytotoxicité
(TransWell® method)
de nos matériaux sur
cellules fibroblastes



Mesures faites au LMGE, dépendant des stagiaires BUT 1 fois/an

Application Environnement (idée J. Lao)

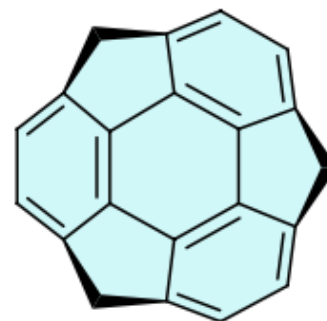
Rétention sélectives
de radionucléides

Collaborations possibles au sein du pôle ?

Selective ionic exchange for radionuclide removal

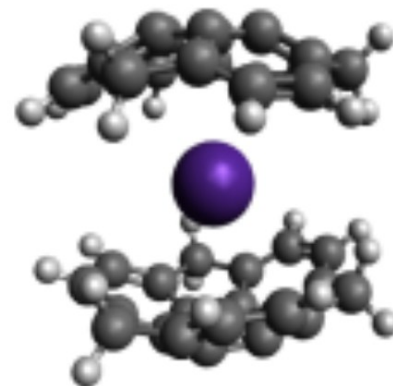
Example 1: Selective Cesium detection with sumanenes

- Sumanene is a bowl-shaped fragment of fullerene C_{60}
- Formation of cation- π complexes with e.g. Li^+ , Na^+ , K^+ , Cu^+ , NH_4^+ ...



sumanene (1)

- Formation of sandwich-like complex with Cs^+ involving 2 sumanene molecules :
perfect size match of Cs^+ and sumanene bowl radii



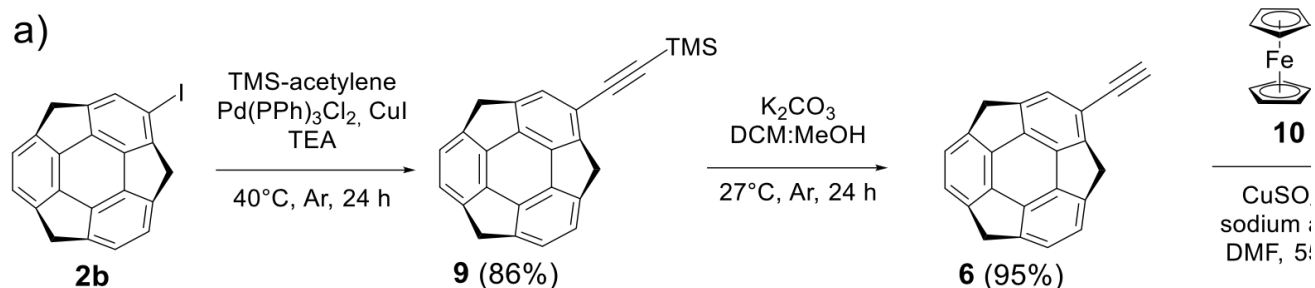
- => selective molecular receptors ?

$Cs^+ (1)_2$
sandwich complex

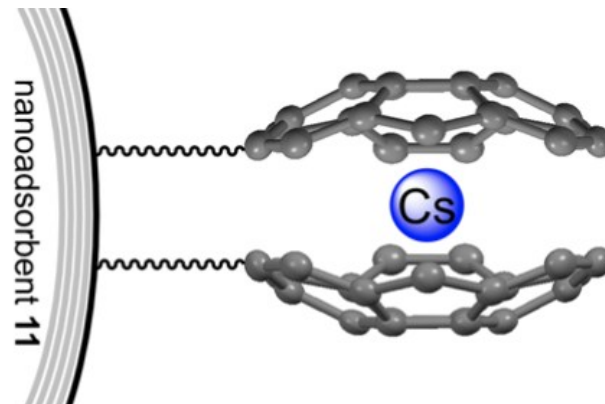
Selective Cesium detection: sumanenes

- Sumanenes are already processed in click chemistry...

Scheme 1. (a) Synthesis of Monoferrocenylsumanene **7** by the CuAAC (*Click Chemistry*) .
Compound **8** by the Sonogashira Cross-Coupling Reaction

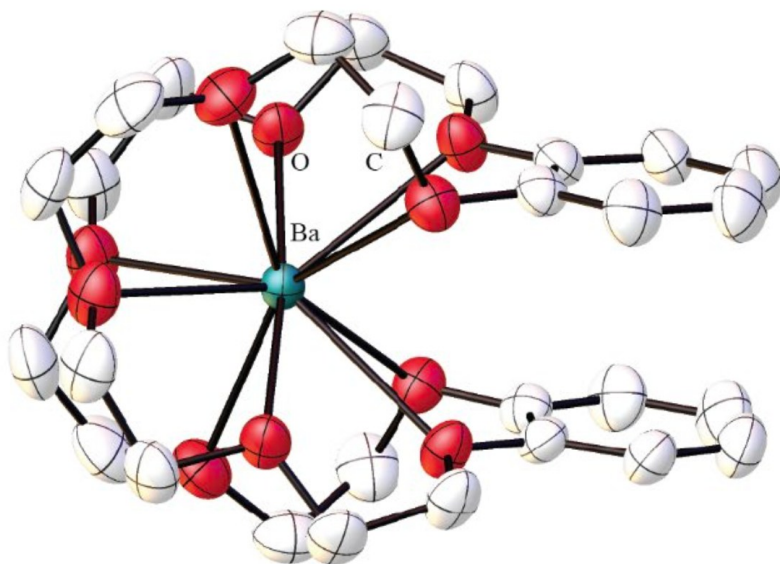
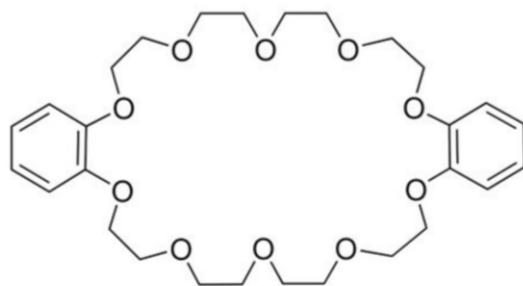


- Supramolecular interactions between Cs⁺ and sumanenes are highly selective, even in the excess (10 x) of other cations such as Li⁺, Na⁺, K⁺, Mg²⁺, Ca²⁺, Rb⁺, even Ba²⁺ which owns similar van der Waals radius as Cs⁺ does not interfere

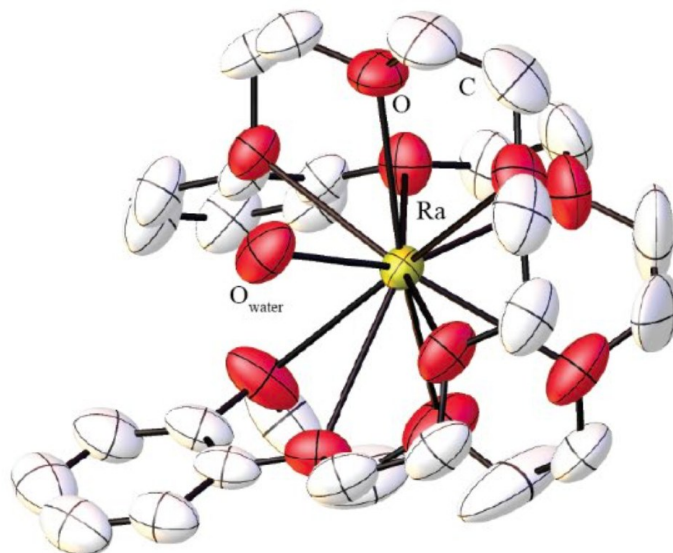


Example 2: Selective Radium detection with crown ether complexes

Dibenzo-30-crown-10

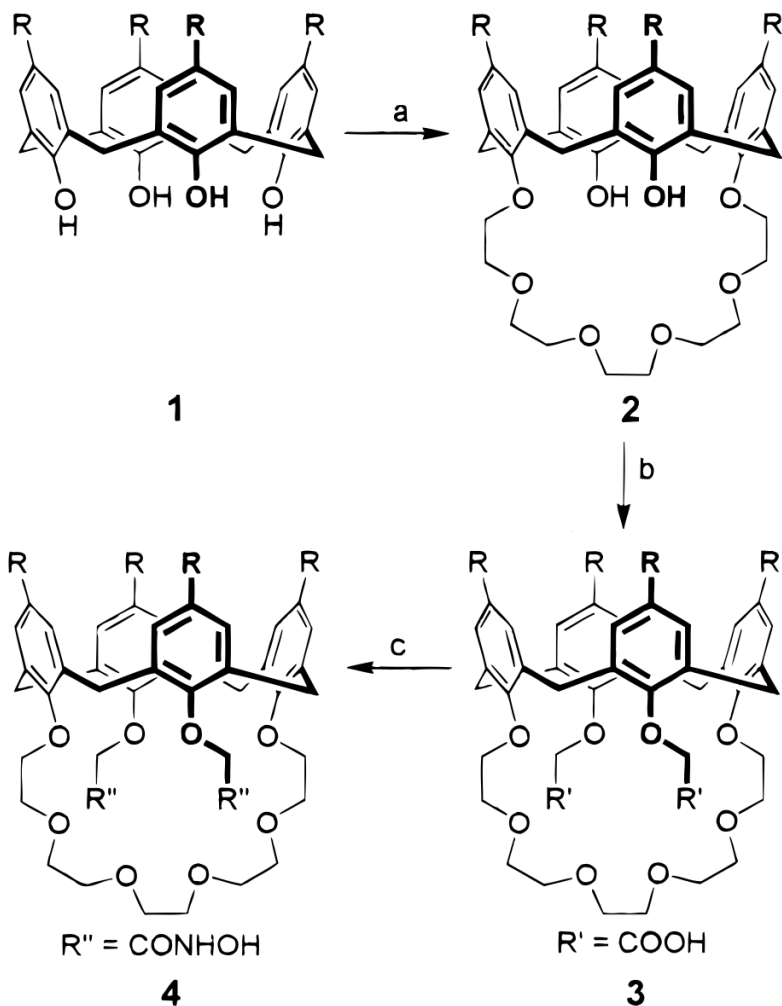


Barium : (Ba²⁺) yielded a 10-coordinate “Pac-Man” structure lacking water



Radium: 11-coordinate Ra²⁺ structure arising from the 10 donor atoms of DB30C10 and a bound water molecule

Selective Radium detection: calixarene crown ether complexes



The selectivity of ligands **3** and **4** for Ra^{2+} versus other alkaline earth metal ions was evaluated by competition experiments between water containing five alkaline earth metal ions (5 cm³, [Ra^{2+}] 0.03 mg/L, [Mg^{2+}] [Ca^{2+}] [Sr^{2+}] [Ba^{2+}] 0.20 mM)

ligands **3** and **4** were able to extract Ra^{2+} almost quantitatively. The extractability of the alkaline earth metal ions followed the order $\text{Ra}^{2+} > \text{Ba}^{2+} > \text{Sr}^{2+} > \text{Ca}^{2+} > \text{Mg}^{2+}$.