

Auto-Assemblage: des Matériaux Moléculaires aux Virus

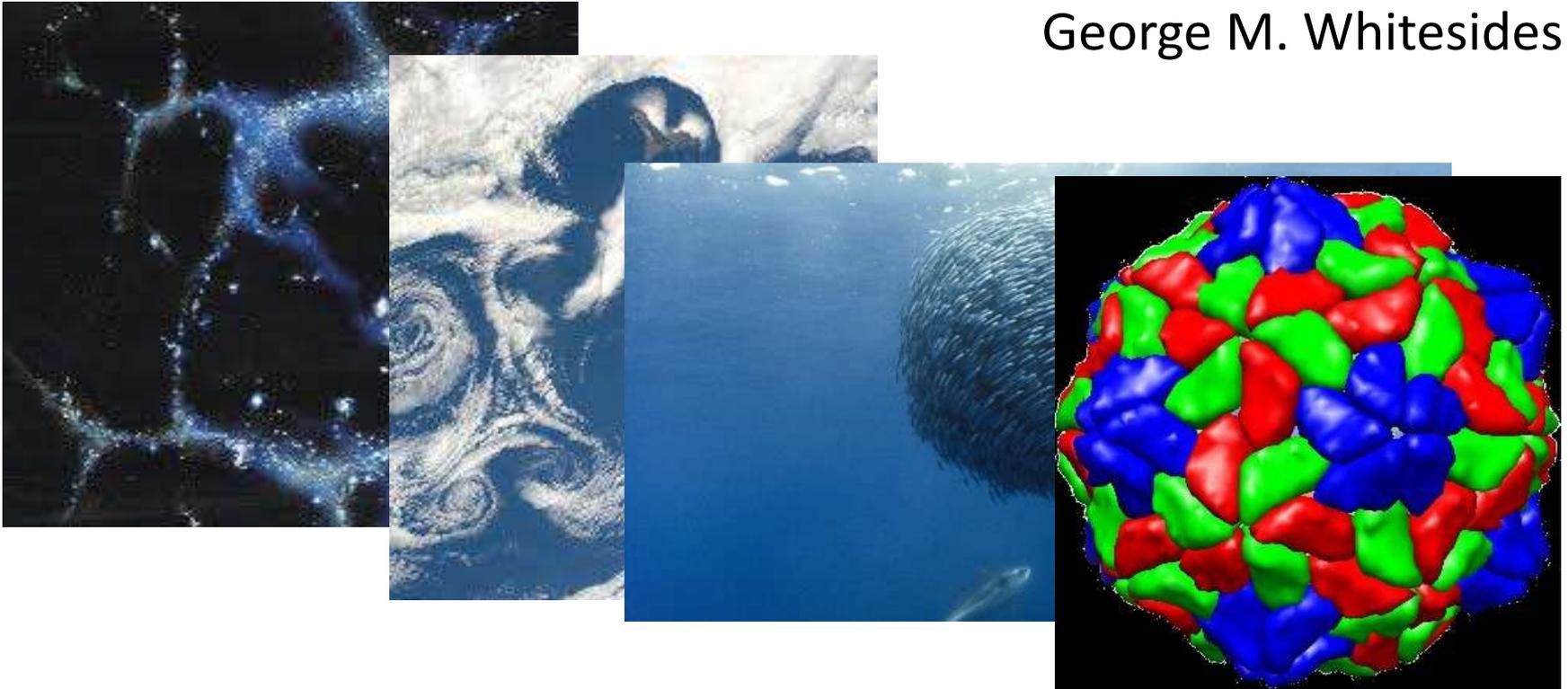
Guillaume TRESSET

*Laboratoire de Physique des Solides
Université Paris-Sud, CNRS*

Quelques Exemples à Différentes Echelles

« L'auto-assemblage est l'organisation autonome de composants en motifs ou structures sans intervention humaine. »

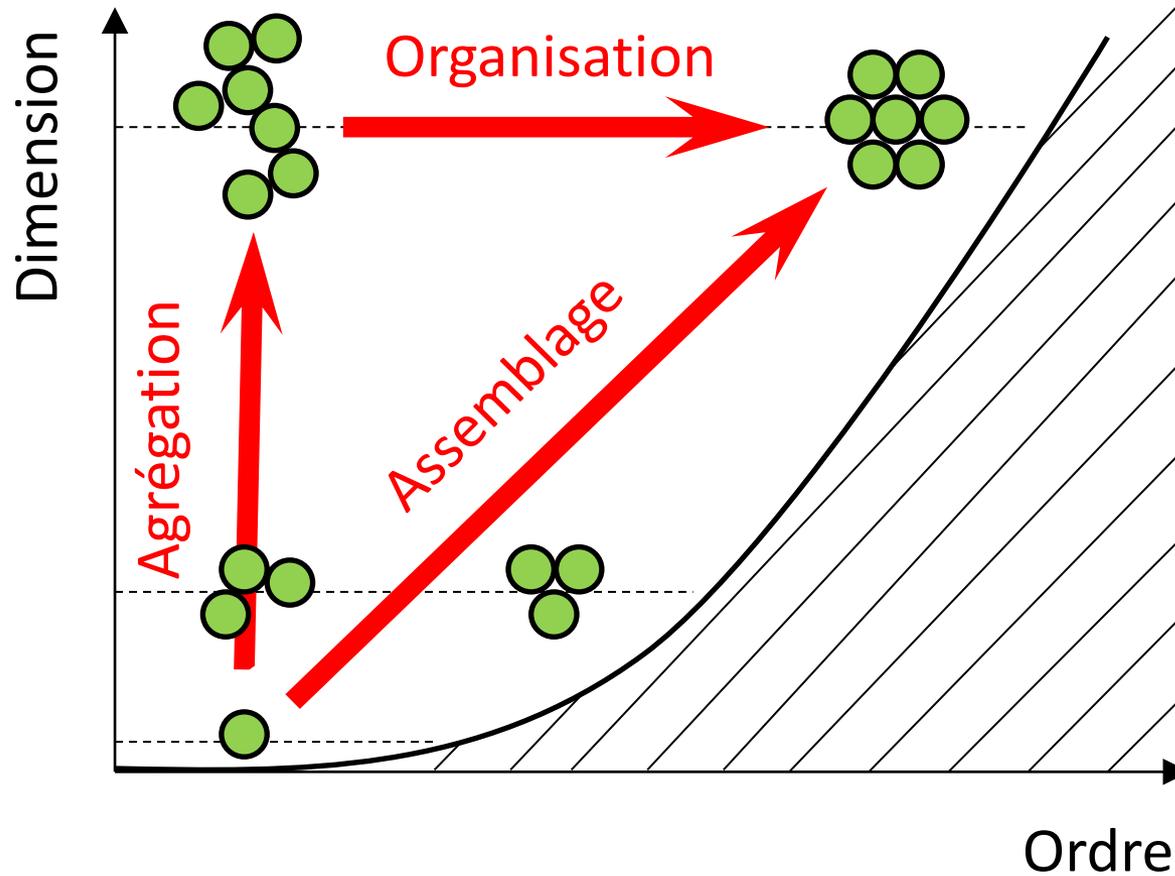
George M. Whitesides



Vers une Définition Plus Précise

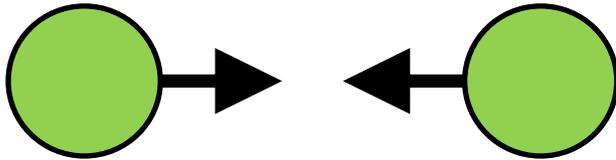
L'auto-assemblage est un processus générique au cours duquel des éléments inanimés de matière s'assemblent de manière spontanée et autonome, par le jeu des forces qui s'exercent entre ces éléments et par apport d'énergie.

Diagramme Schématique des Modes d'Association



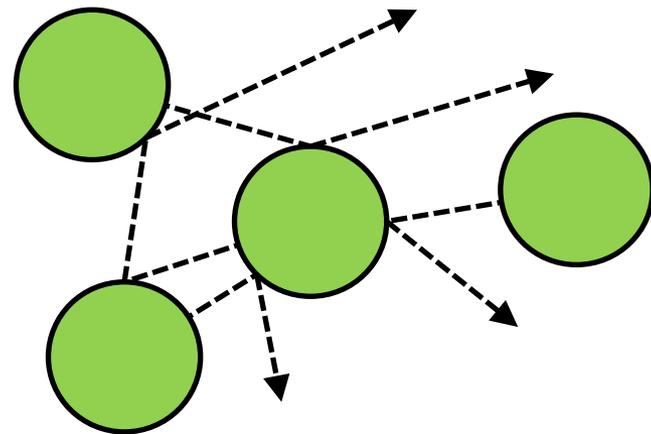
Ingrédients Requis pour l'Auto-Assemblage

Attraction



- Gravitation
- Force magnétique
- Force électrostatique
- Liaison chimique
- ...

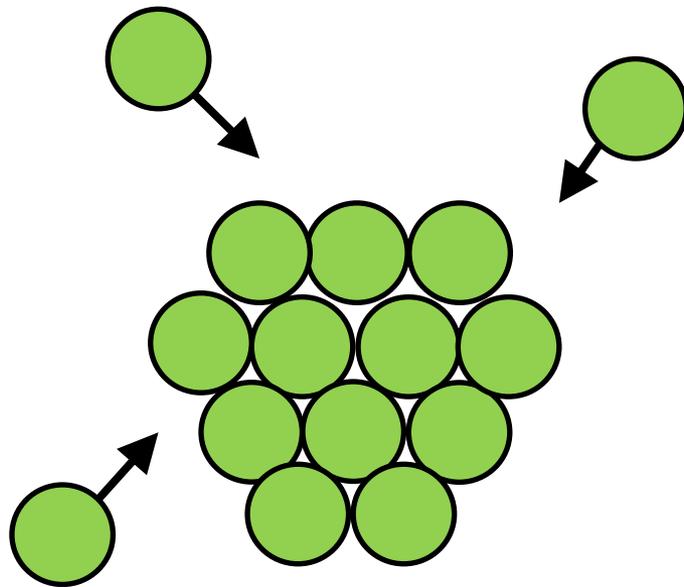
Agitation



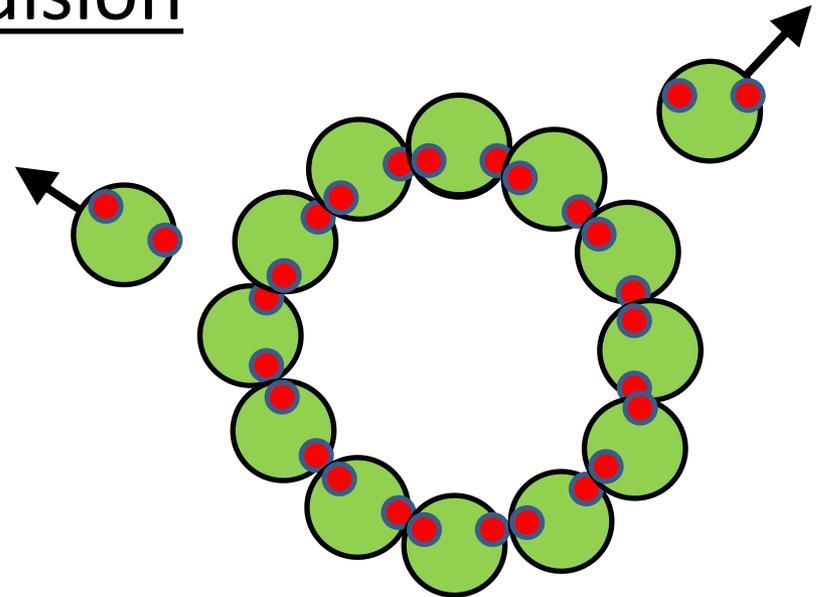
- Mécanique
- Thermique (et entropie)

Un Troisième Ingrédient pour Contrôler la Dimension

Répulsion

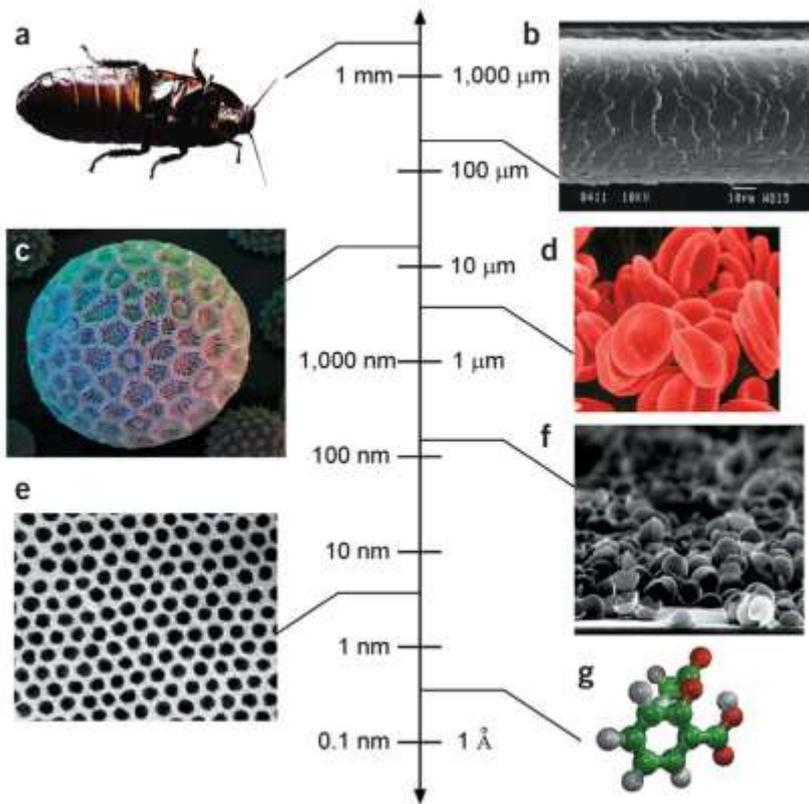


Croissance infinie



- Stérique
- Electrostatique
- ...

Echelle des Dimensions



1 m

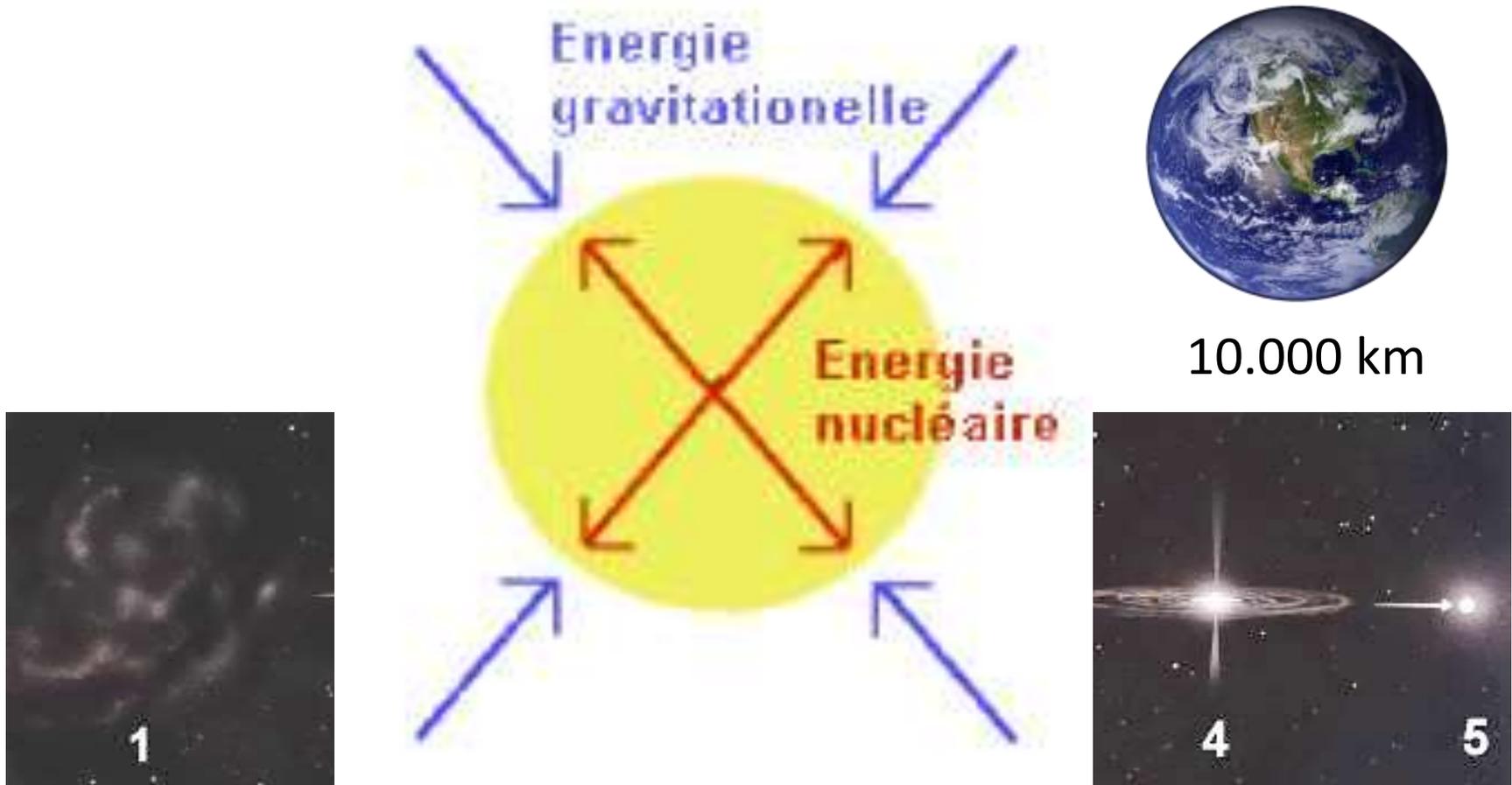


10.000 km



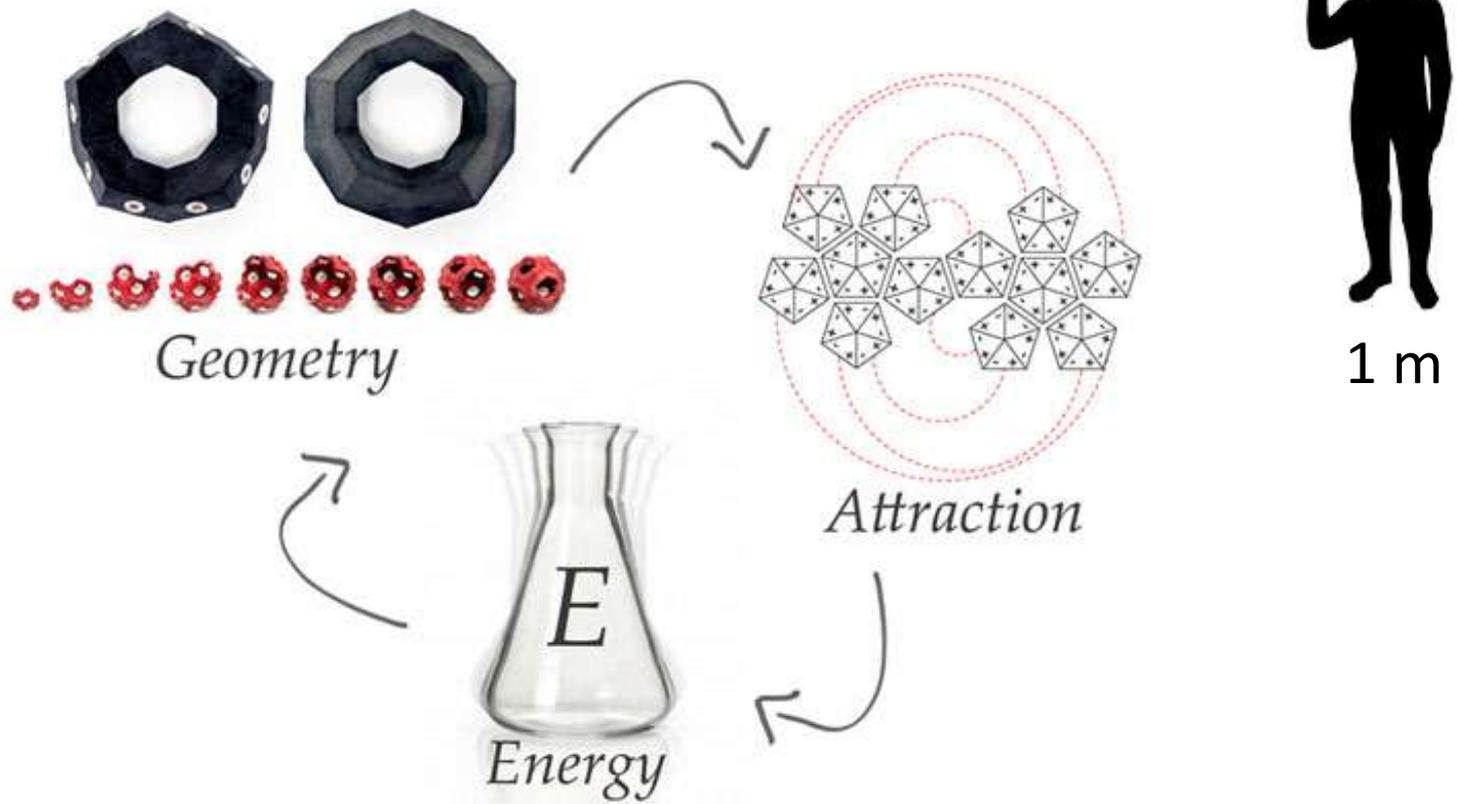
1.000.000.000.000.000.000.000 km

Formation d'une Etoile



Un Auto-Assemblage à Réaliser Soi-Même

© Skylar Tibbits, MIT



Un Auto-Assemblage à Réaliser Soi-Même



www.pnas.org/content/suppl/2007/12/05/0709489104.DC1/09489Movie1.mov

Et Pourquoi Pas pour le Design ?

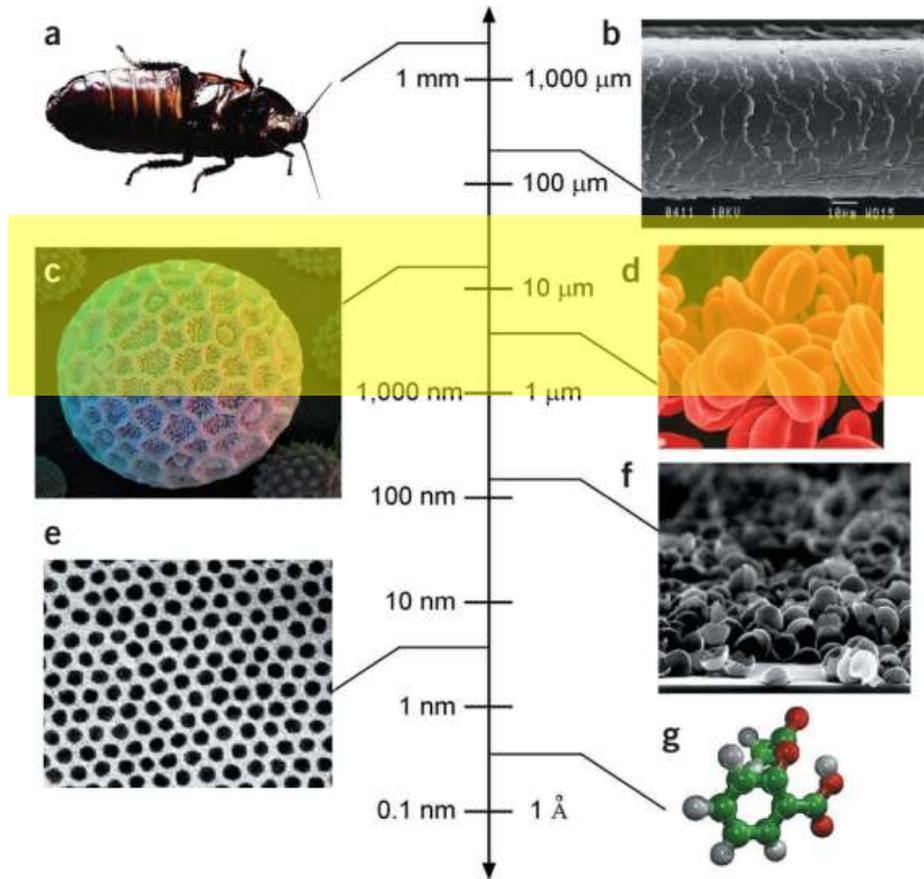
© Skylar Tibbits, MIT



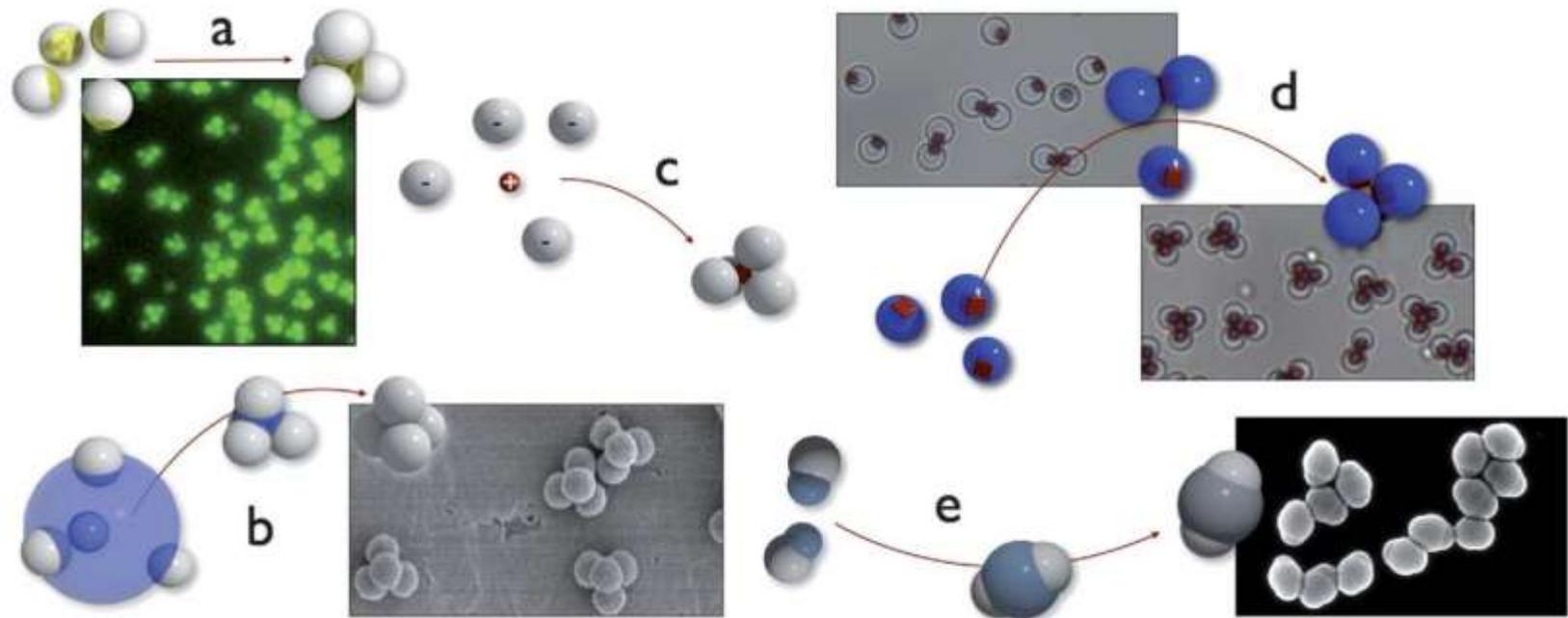
Bientôt dans les Usines ?

© Skylar Tibbits, MIT



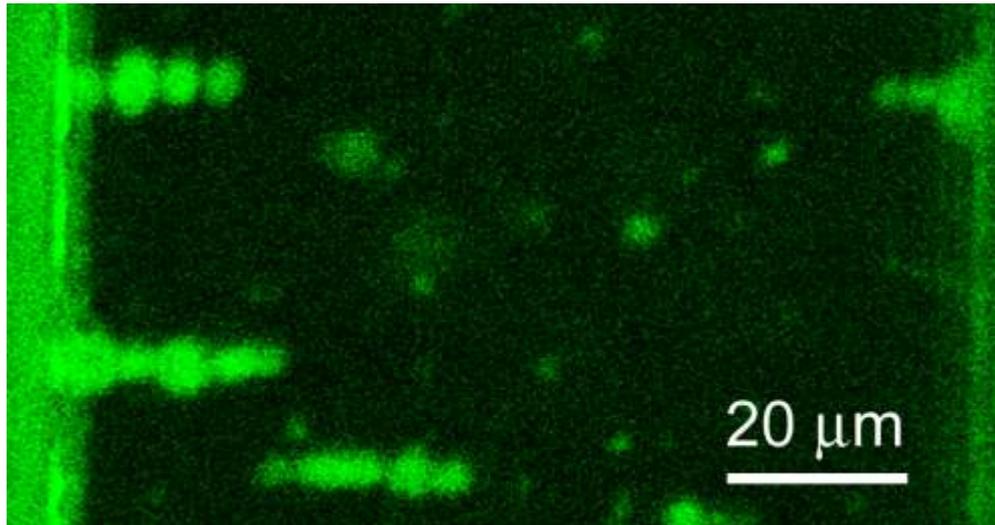
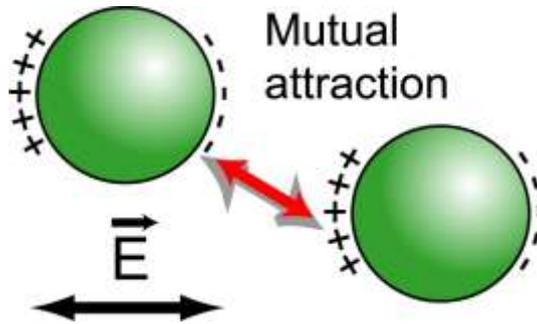


Diverses Façons d'Assembler des Colloïdes

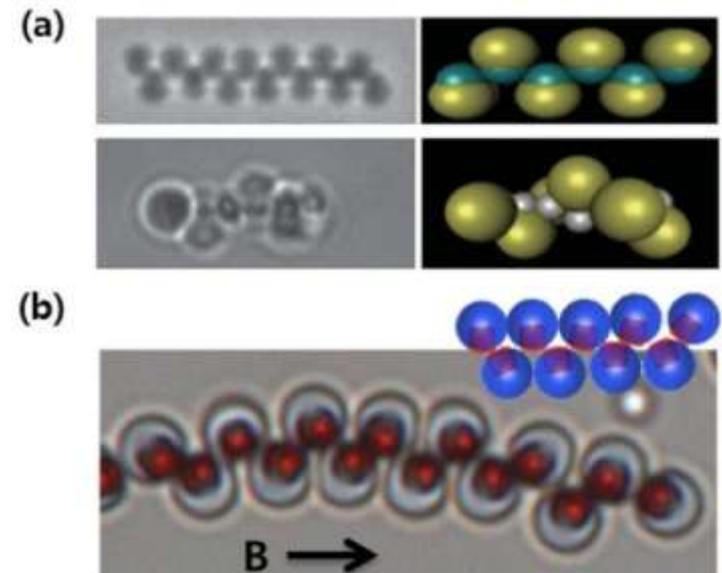


Sacanna, *Soft Matter* 2013

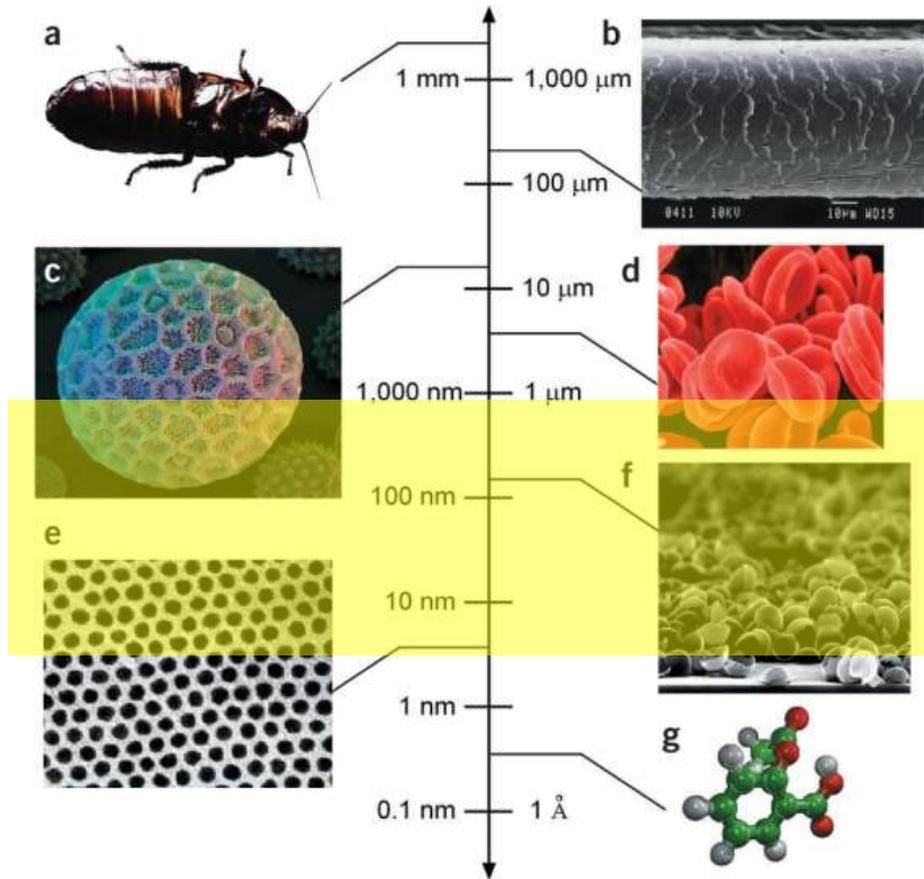
Chaînes Auto-Assemblées de Colloïdes



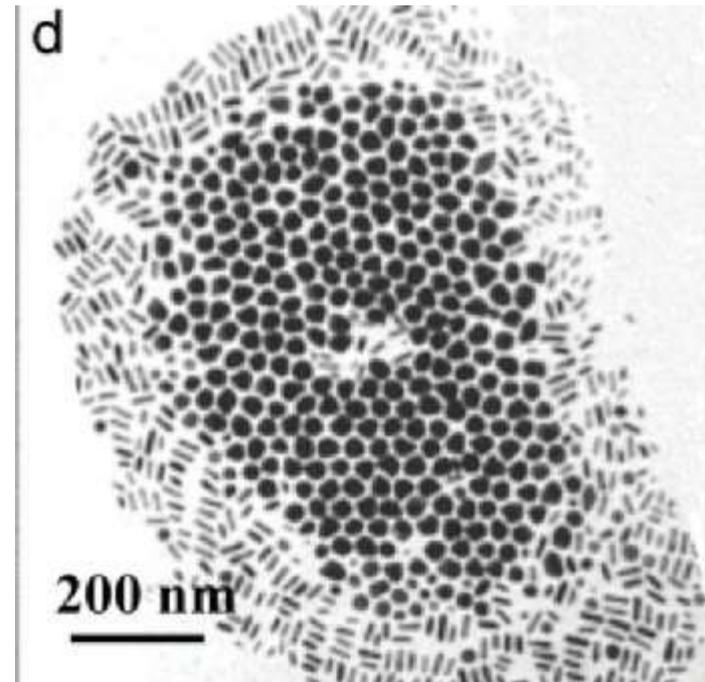
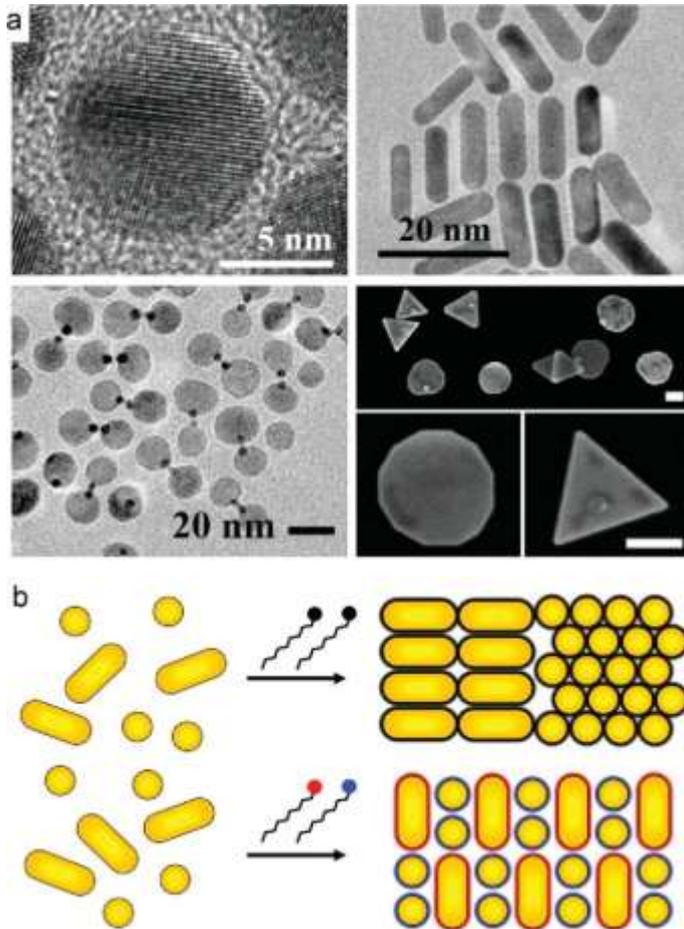
Tresset, *Appl. Phys. Lett.* 2007



Yi, *J. Phys.: Condens. Matter* 2013

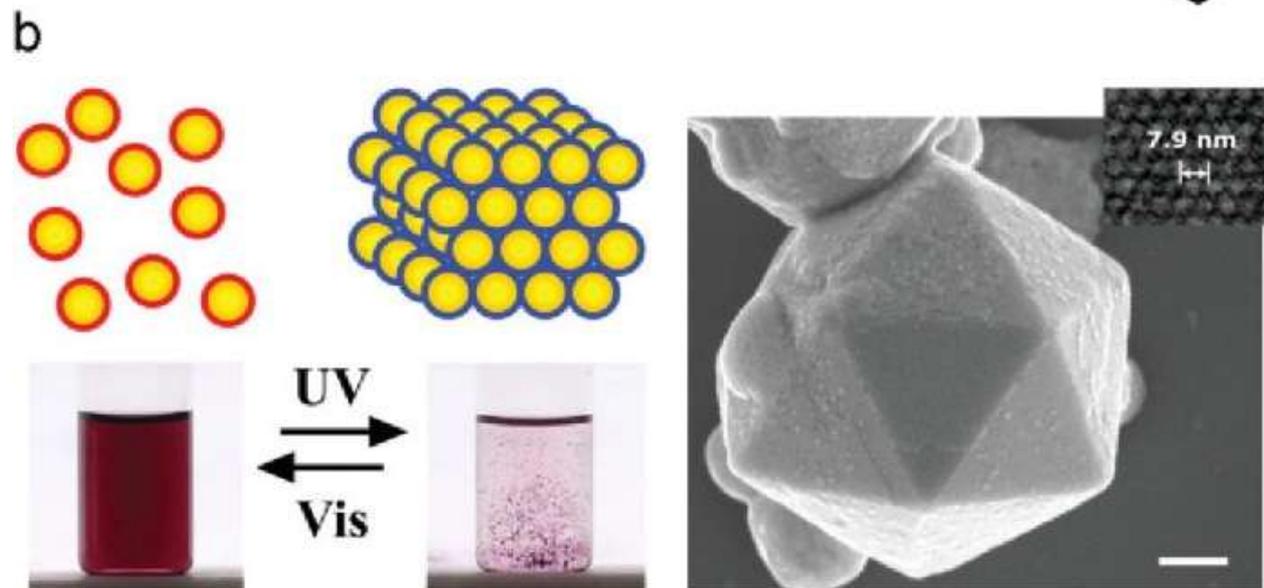
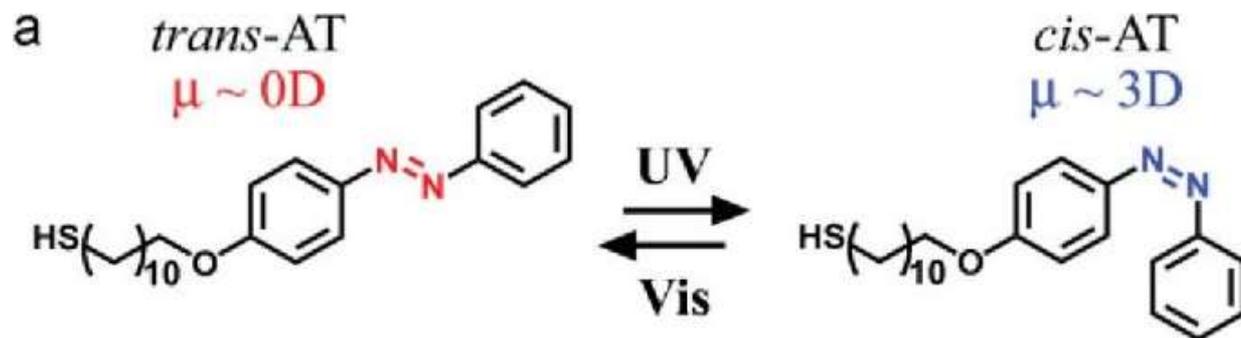


Assemblages de Nanoparticules Inorganiques



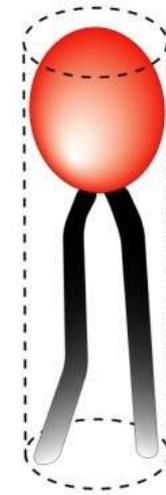
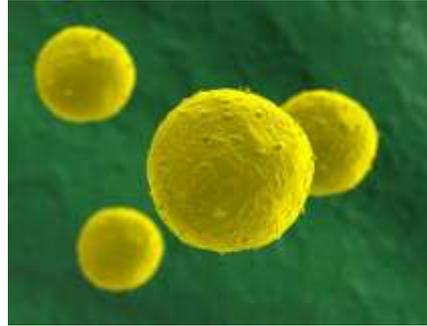
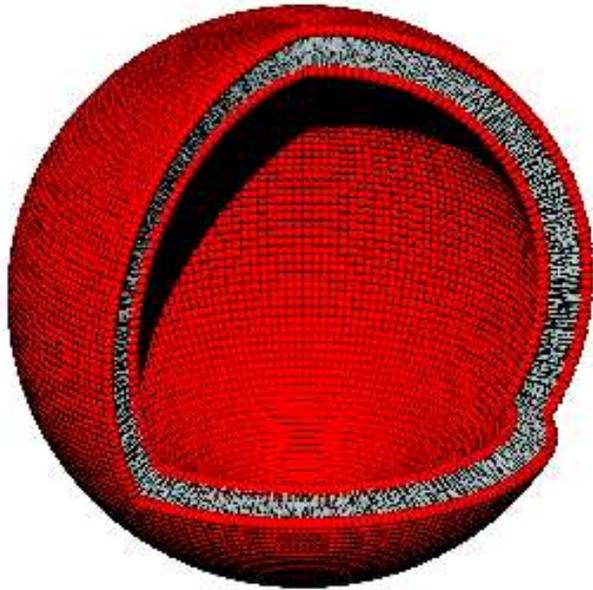
Bishop, *Small* 2009

Contrôle Réversible de l'Assemblage

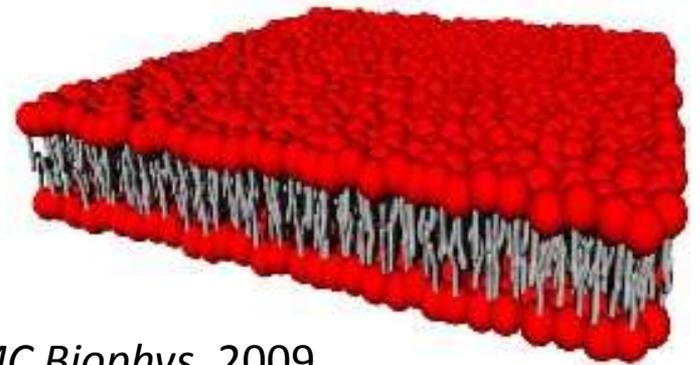


Bishop, *Small* 2009

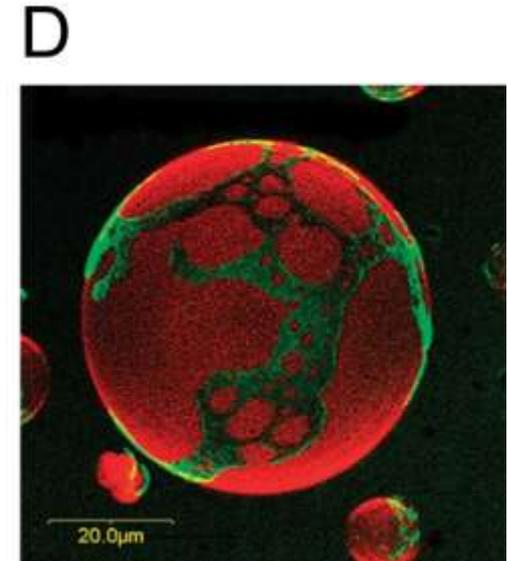
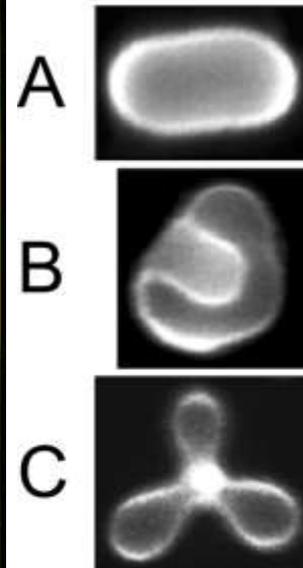
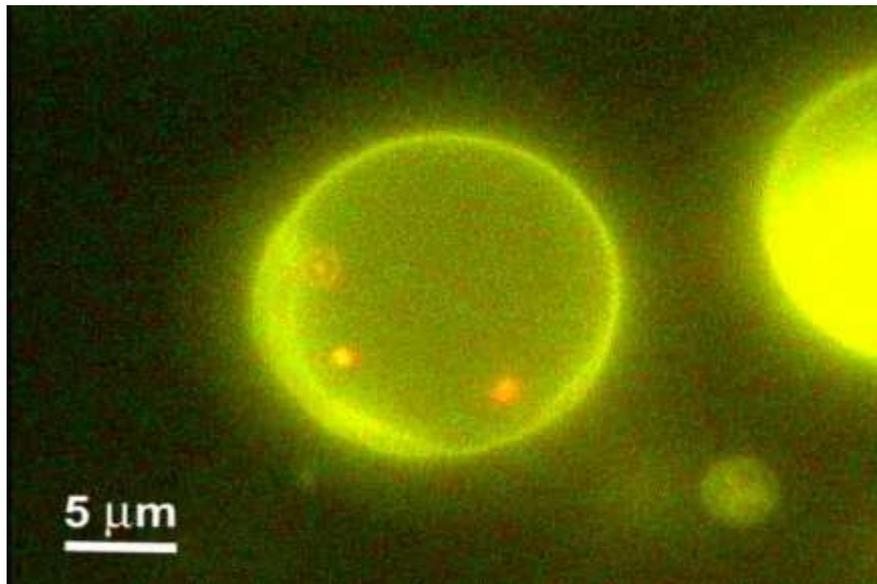
Lipides et Membranes Lipidiques



- Mime les parois cellulaires.
- Taille de 50 nm à 50 μm .



Tresset, *PMC Biophys.* 2009

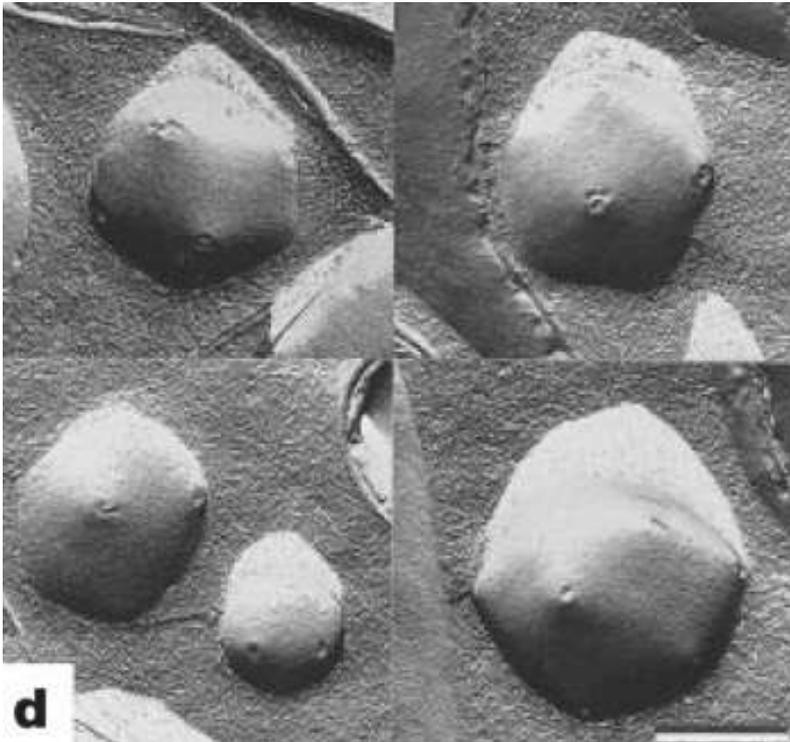


Tresset, *Anal. Chem.* 2005

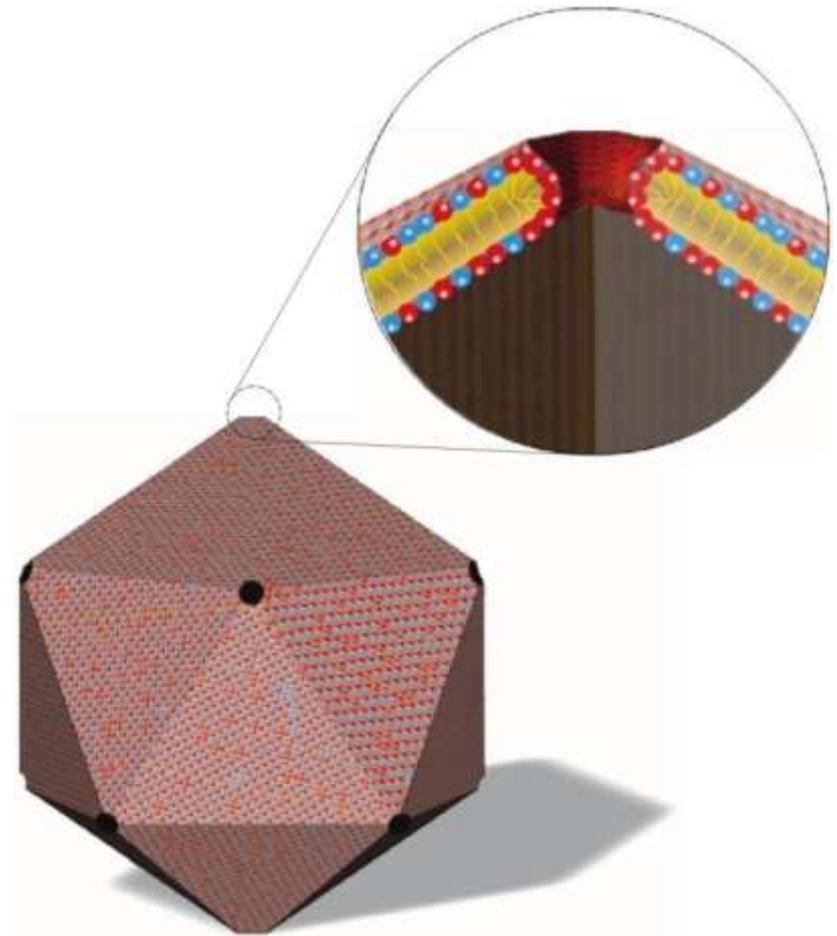
Tresset, *PMC Biophys.* 2009

- Capsules biomimétiques.
- Utilisation dans les cosmétiques et médicaments.

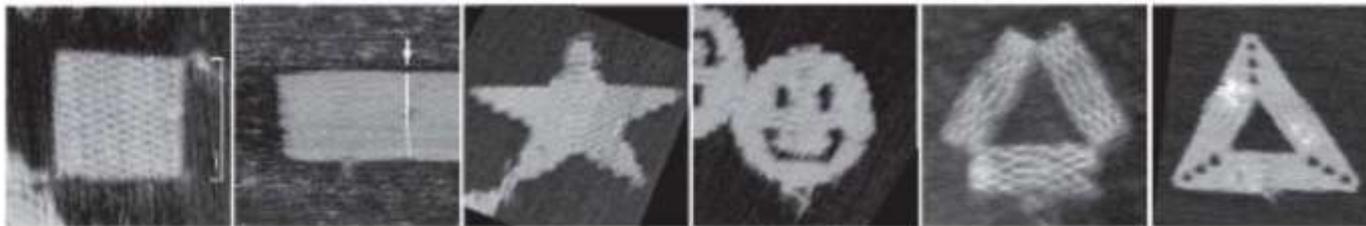
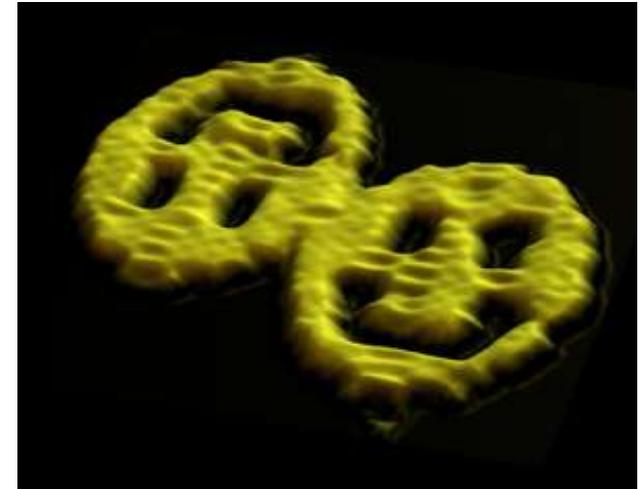
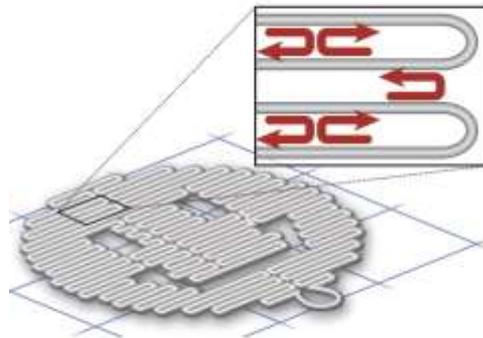
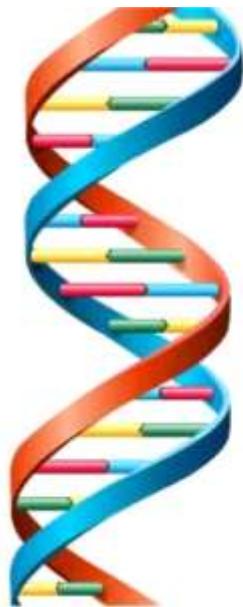
Vésicules Icosaédriques



Dubois, *Nature* 2001

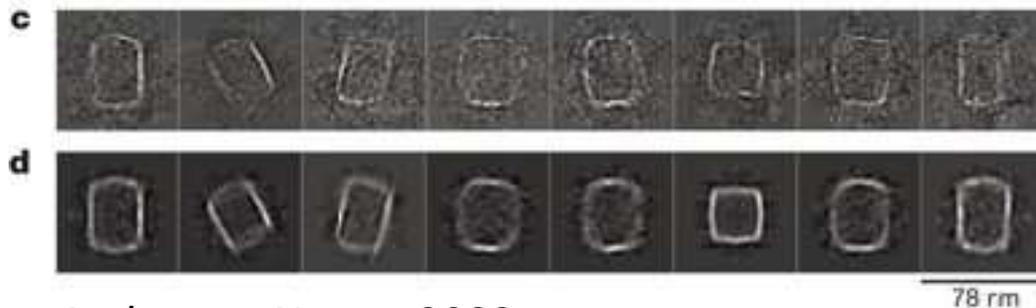
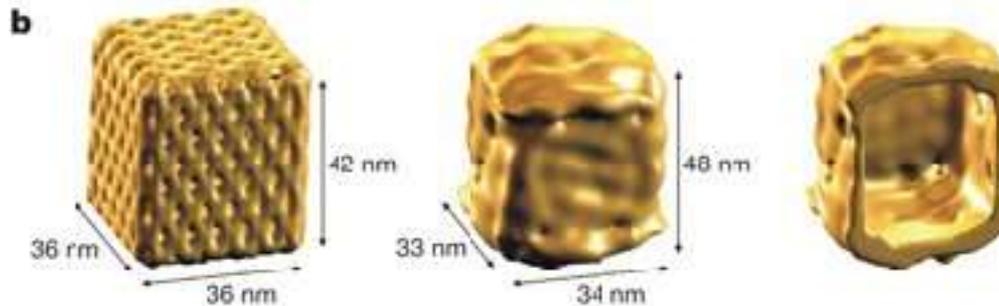
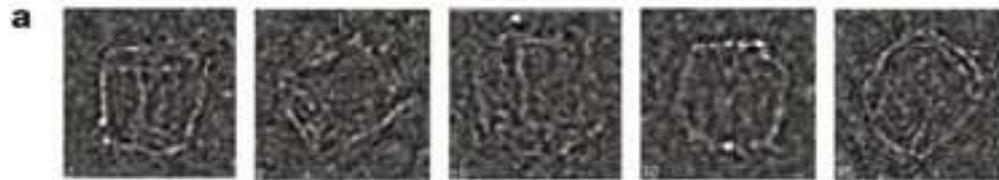


Origamis d'ADN

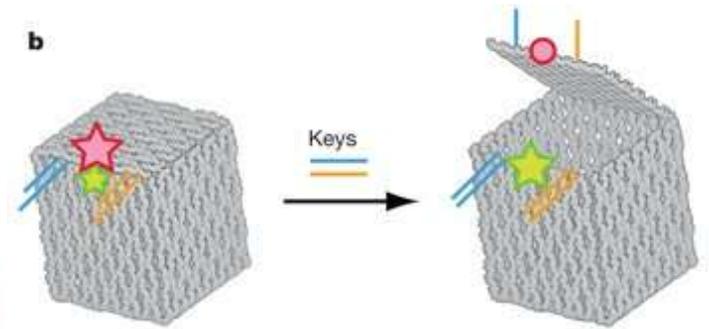


Rothemund, *Nature* 2006

Nanoboîtes à ADN avec Ouverture Contrôlée

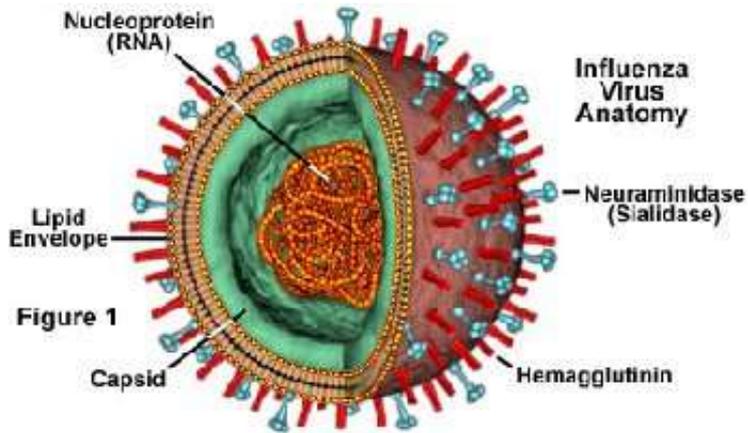


Andersen, *Nature* 2009

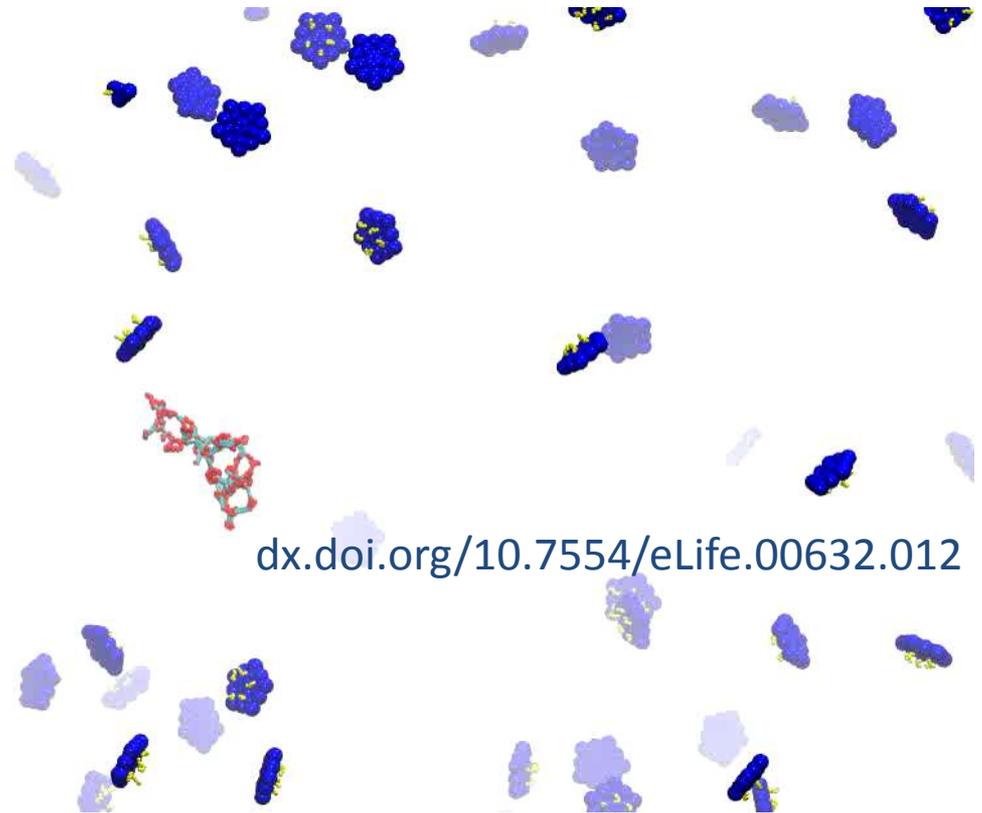


- Ouverture contrôlée par clés d'ADN.
- Utilisation future en médecine ?

Auto-Assemblage de Virus



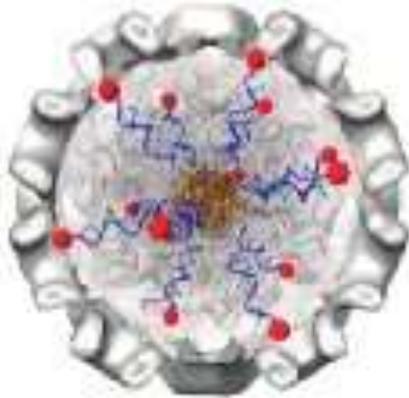
- Virus = coquille + génome.
- Auto-assemblage naturel.



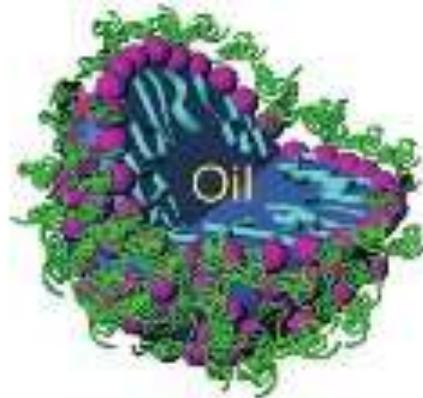
[dx.doi.org/10.7554/eLife.00632.012](https://doi.org/10.7554/eLife.00632.012)

Perlmutter, *eLIFE* 2013

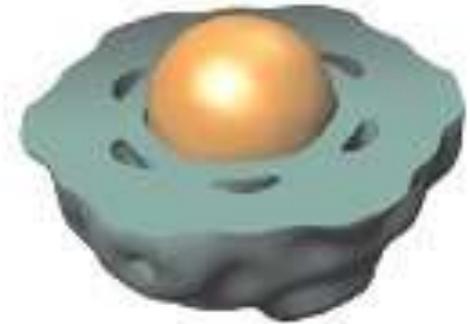
Applications pour des Virus Modifiés



ADN pour le transfert
de gènes



Emulsion pour le
transport de
médicaments



Particule magnétique
pour l'imagerie IRM

Merci pour votre attention !