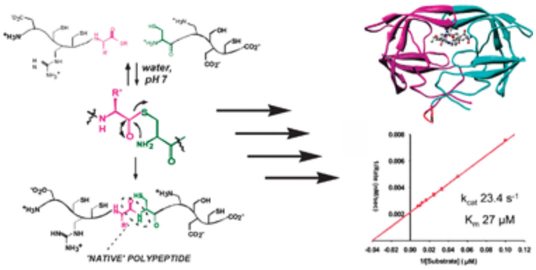
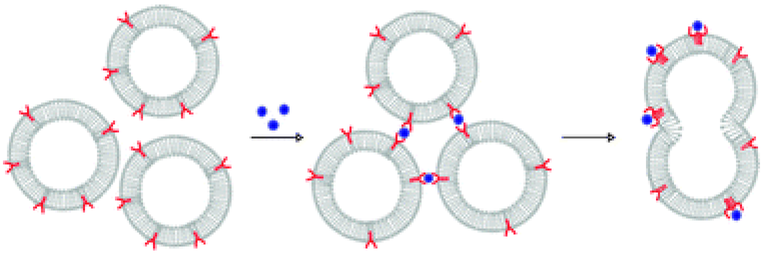
- Total chemical synthesis of proteins
  Kent, S. B. H. *Chem. Soc. Rev.* **2009**, *38*, 338 – 351.
  Abstract:



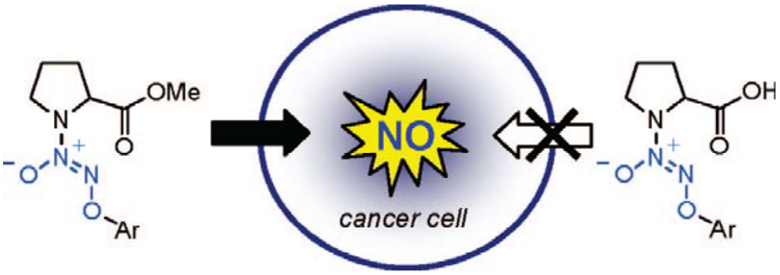
This *tutorial review* outlines the modern ligation methods that enable the efficient total chemical synthesis of enzymes and other protein molecules. Key to this success is the chemoselective reaction of unprotected synthetic peptides (ˋchemical ligation ´). Notably, native chemical ligation enables the reaction of two unprotected peptides in aqueous solution at neutral pH to form a single product in near quantitative yield. Full-length synthetic polypeptides are folded to form the defined tertiary structure of the target protein molecule, which is characterized by mass spectrometry, NMR, and X-ray crystallography, in addition to biochemical and/or biological activity.

- Molecular recognition of bilayer vesicles
  Voskuhl, J.; Ravoo, B. J. *Chem. Soc. Rev.* **2009**, *38*, 495 – 505.
  Abstract:



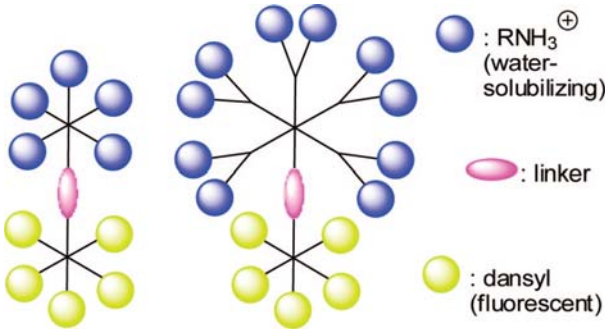
Vesicles have been a versatile topic of research in chemistry ever since the discovery that, besides phospholipids, synthetic amphiphiles can also form molecular bilayers enclosing a small aqueous compartment. Non-covalent interactions of receptors and ligands or hosts and guests at vesicle surfaces resemble recognition processes at biological membranes, including cell recognition, adhesion and fusion. Molecular recognition at membranes is often mediated by a multivalent instead of a monovalent interaction. This *tutorial review* describes the basics as well as the latest developments in biomimetic supramolecular chemistry of bilayer vesicles. We describe how molecular recognition can mediate the interaction between vesicles, and how the biomimetic supramolecular chemistry of vesicles furthers our understanding of biological membranes.

- Cell-Permeable Esters of Diazeniumdiolate-Based Nitric Oxide Prodrugs
  Chakrapani H.; Maciag A. E.; Citro M. L.; Keefer L. K.; Saavedra J. E. *Org. Lett.* **2008**, *10*, 5155-5158.
  Abstract:



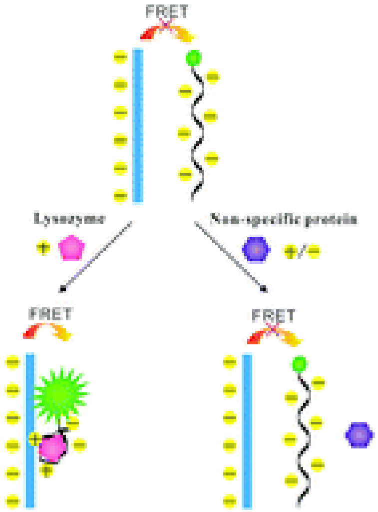
Although O^2-(2,4-dinitrophenyl) derivatives of diazeniumdiolate-based nitric oxide (NO) prodrugs bearing a free carboxylic acid group were activated by glutathione to release NO, these compounds were poor sources of intracellular NO and showed diminished antiproliferative activity against human leukemia HL-60 cells. The carboxylic acid esters of these prodrugs, however, were found to be superior sources of intracellular NO and potent inhibitors of HL-60 cell proliferation.

- Cationic and Fluorescent "Janus" Dendrimers
  Fuchs S.; Pla-Quintana A.; Serge Mazères S.; Caminade A.-M.; Majoral J.-P. *Org. Lett*. **2008**, *10*, 4751-4754.
  Abstract:



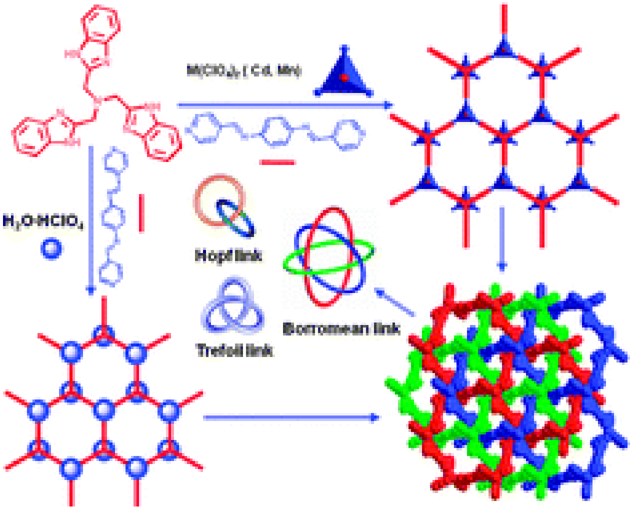
Two synthetic routes to "Janus"-type dendrimers possessing ammonium groups on one side and fluorescent dansyl derivatives on the other side are described. These surface-block dendrimers are obtained by the coupling of two different dendrons, built from the hexafunctional cyclotriphosphazene core. Their characterization and their photophysical behavior are reported. The largest compound possesses 10 ammonium groups and 5 dansyl groups; it is potentially useful as a fluorescent label in materials science and biology.

- Fluorescence resonance energy transfer between an anionic conjugated polymer and a dye-labeled lysozyme aptamer for specific lysozyme détection.
  Wang, L.; Liu, B. *Chem. Commun.* **2009**, 2284 – 2286.
  Abstract:



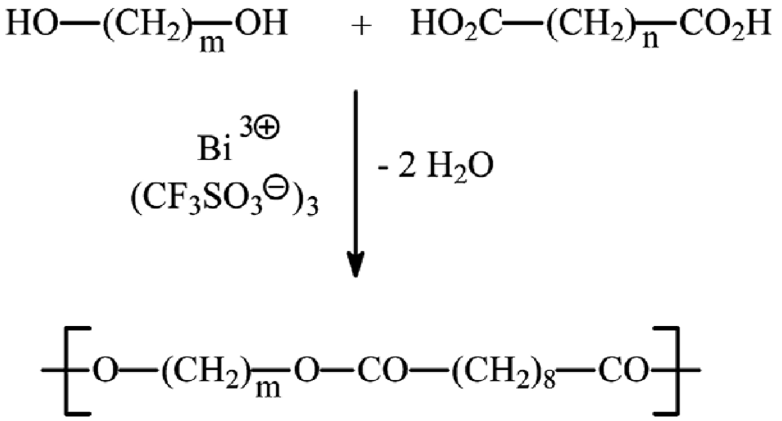
Surface charge switch of a 6-carboxyfluorescein (FAM) labeled lysozyme aptamer from negative to positive upon lysozyme binding triggers fluorescence resonance energy transfer (FRET) between an anionic conjugated polymer and the aptamer, which provides a convenient method for lysozyme detection in biological media with high sensitivity and selectivity.

- Self-assembly of 2D Borromean networks through hydrogen-bonding recognition.
  Jang, J. J.; Li, L.; Yang, T.; Kuang, D. B.; Wang, W.; Su, C. Y. *Chem. Commun.* **2009**, 2387 – 2389.
  <u>Abstract :</u>



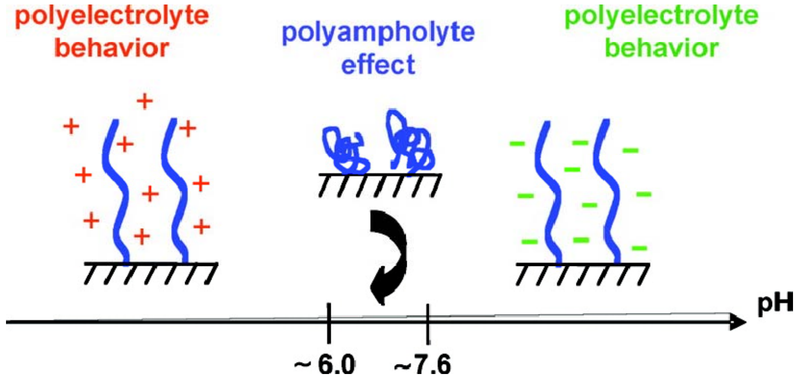
Assembly of a tripodal ligand tris(2-benzimidazoylmethyl)amine with the long rod-like spacer N^1,N^4-bis(pyridin-4-ylmethylene)-benzene-1,4-diamine in the presence of $M(ClO_4)_2$ (M = Cd^{2+} and Mn^{2+}) or $H_3O{\cdot}ClO_4$ leads to formation of 6^3-hcb layers which interweave in a parallel fashion to give the first examples of hydrogen-bonding Borromean links.

- Aliphatic Polyesters by Bismuth Triflate-Catalyzed Polycondensations of Dicarboxylic Acids and Aliphatic Diols.
  Buzin, P.; Lahcini, M.; Schwarz, G.; Kricheldorf, H. R. *Macromolecules* **2008**, *41*, 8491-8495.
  <u>Abstract:</u>



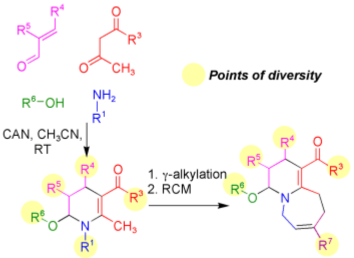
Polycondensations of aliphatic dicarboxylic acids (ADAs) with 1,4-butane or 1,6-hexane diol were conducted in bulk at 80 or 100 °C. Temperature and monomer/catalyst ratio were varied. With bismuth triflate, Bi(OTf)3, as catalyst, number average molecular weights (*M*n's, uncorrected SEC data) up to 30 000 Da were obtained. Analogous polycondensations were performed with the triflates of sodium, magnesium, aluminum, zinc, tin(II), scandium, and hafnium, but the highest *M*n values were achieved with Bi(OTf)3. Polycondensations and model experiments proved that most triflates catalyzed the formation of tetrahydrofuran from 1,4-butane diol above 100 °C. Therefore, polycondensations of 1,4-butane diol required temperatures e100 °C. Polycondensations of 1,4-butene diol or 1,4-butyne diol were unsuccessful, because of side reactions. All polycondensations involved rapid equilibrations, and the content of cyclic oligo- and polyesters increased with the conversion.

- Stimuli-Responsive Interfaces Using Random Polyampholyte Brushes.
  Sanjuan, S.; Tran, Y. *Macromolecules* **2008**, *41*, 8721-8728.
  Abstract:



We study the pH-responsive behavior of random polyampholyte brushes synthesized by surfaceinitiated Atom Transfer Radical Polymerization. We define the "annealed" polyampholyte as the random copolymer that contains weak acid (methacrylic acid) and weak base (2-(dimethylamino)ethyl methacrylate) units. The "semiannealed" polyampholyte is defined as the random copolymer that contains the methacrylic acid and a strong base unit (the quaternized amine). The structure of the polyampholyte brushes in aqueous solutions at different pH is determined using neutron reflectivity. The monomer density profile and therefore the brush thickness are obtained. Polymer brushes with various grafting densities are compared. We demonstrate that the structure of the polyampholyte brush depends strongly on the net charge of the chains. With an excess of charge, the brush is as stretched as a polyelectrolyte brush, and the swelling behavior is in good agreement with the scaling laws. At the isoelectric point corresponding to a zero net charge, the polyampholyte effect dominates, resulting in the collapse of the chains. We find that weakly dense polyampholytes have the greatest amplitude of stretchingcollapse. We also compare the responsive behavior of the random polyampholyte brushes with that of diblock polyampholyte brushes and mixed polyelectrolyte brushes.

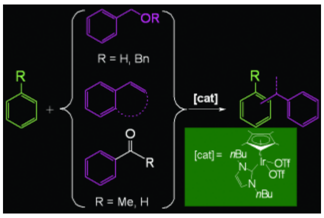
- A Very Efficient Cerium(IV) Ammonium Nitrate Catalyzed, Four-Component Synthesis of Tetrahydropyridines and Its Application in the Concise Generation of Functionalized Homoquinolizine Frameworks
  Sridharan, V.; Maiti, S.; Menéndez, J. C. *Chem. Eur. J.* **2009**, *15*, 4565-4572.
  Abstract:



Molecular diversity: A cerium(IV) ammonium nitrate (CAN) catalyzed, four-component reaction from very simple acyclic starting materials afforded densely substituted tetrahydropyridines, which were transformed into homoquinolizines by using a γ-alkylation-ring-closing metathesis (RCM) sequence (see scheme).

The cerium(IV) ammonium nitrate (CAN) catalyzed, four-component reaction between primary aliphatic amines, β-ketoesters or β-ketothioesters, α,β-unsaturated aldehydes, and alcohols provided a very efficient and atom-economical access to substituted 6-alkoxy-2-methyl-1,4,5,6-tetrahydropyridines. These materials were then transformed into homoquinolizine derivatives in excellent yields by using a two-step sequence comprised of regioselective γ-deprotonation-allylation and ring-closing metathesis reactions. The possibility of displacing the alkoxy group by allylsilane nucleophiles, presumably through a vinylogous acyliminium intermediate species, was also demonstrated.

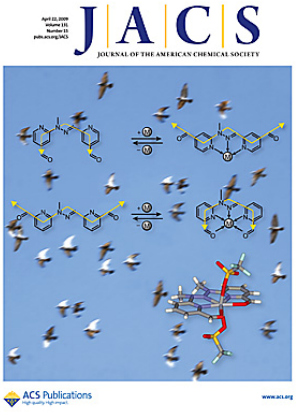
- A Simple Catalyst for the Efficient Benzylation of Arenes by Using Alcohols, Ethers, Styrenes, Aldehydes, or Ketones
  Prades, A.; Corberán, R.; Poyatos, M.; Peris, E. *Chem. Eur. J.* **2009**, *15*, 4610-4613.
  Abstract:

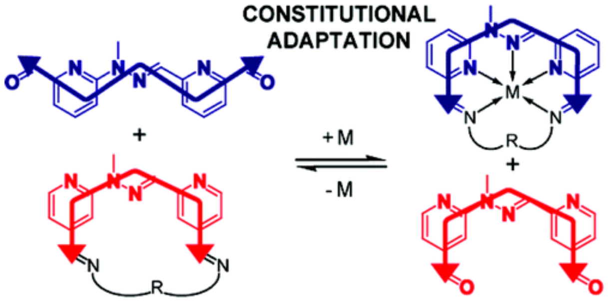


One catalyst fits all! One catalyst is active for a wide set of benzylating reactions (see scheme). A tandem process allows the use of aldehydes and ketones as benzylating agents.

The compound $[IrCp^*(OTf)_2(I^{nBu})]$ (I^{nBu}=1,3-di-*n*-butyl-imidazolylidene) is an effective catalyst in the benzylation of arenes with different benzylating agents, such as alcohols, ethers and styrenes, representing an unprecedented highly versatile catalyst for this type of process. The same compound also catalyses a remarkable tandem process that allows the use of aldehydes and ketones as benzylating agents, through the base-free hydrogenation of C=O bonds with *i*PrOH and further use of the resulting primary or secondary alcohols as benzylating agents.

- Adaptation to Shape Switching by Component Selection in a Constitutional Dynamic System
  Ulrich, S.; Lehn, J.-M. *J. Am. Chem. Soc.* **2009**, *131*, 5546–5559.
  Abstract:

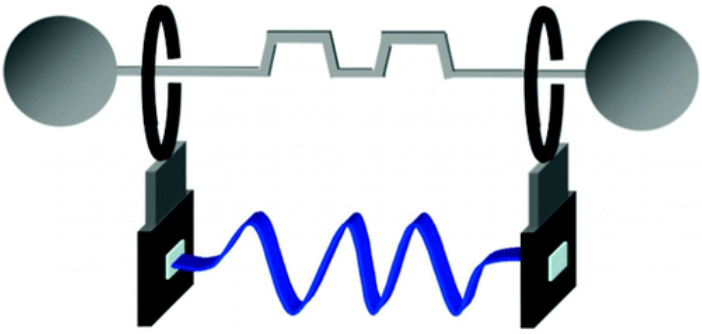




Molecules having different accessible shape states, which can be addressed in an effector-controlled manner, may be termed morphological switches. A dynamic covalent system can undergo adaptation to each state of a two-state morphological switch by generation of an optimal constitution through component selection. We have studied such a component selection in the dynamic covalent constituents generated by metal cation-induced shape switching of a core component between two states of W and U shape, characterized by both different geometries and different coordination features. The system performs shape-dependent self-sorting of metal ions and components. The origin of the selectivity was investigated through competition experiments, in solution and by analysis of solid state structures, which reveal the role of the molecular shape in the formation of a particular self-assembled architecture. The coordination features of each state as well as phase change also play an important role, in addition to the shape plasticity, in steering the covalent dynamic system toward the formation of a given entity by the selection of the most appropriate components. Different examples are described which show that the morphological switching of one component of a given self-assembled entity can lead to the exchange of the complementary one, which is no longer the best partner, for a new partner, able to form a more stable new assembly. Thus, the constitutional evolution of these dynamic systems is steered by the shape of a given state via both its geometry and its coordination features toward metal ions, leading to incorporation/decorporation of the most appropriate components. The controlled interconversion of the shape states of the morphological switches, induced by addition/removal of metal ions, results in a constitutional adaptation behaviour through inversion of the selection preferences.

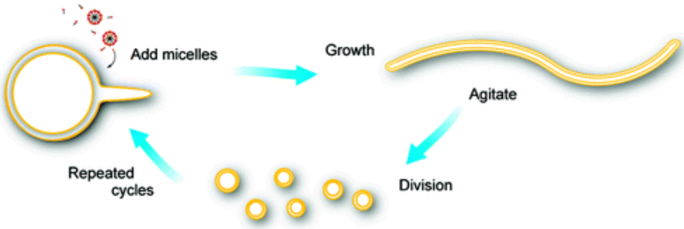
- Adjustable Receptor Based on a [3]Rotaxane Whose Two Threaded Rings Are Rigidly Attached to Two Porphyrinic Plates: Synthesis and Complexation Studies

Collin, J.-P.; Frey, J.; Heitz, V.; Sauvage, J.-P.; Tock, C.; Allouche, L. *J. Am. Chem. Soc.* **2009**, *131*, 5609–5620.
Abstract:



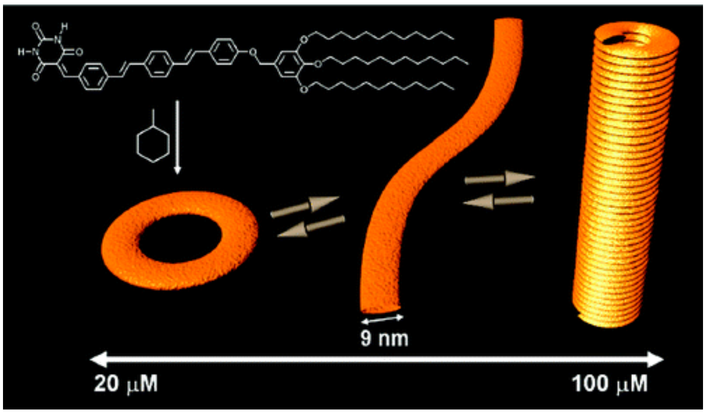
The design and synthesis of a new type of receptor based on a [3]rotaxane, consisting of one thread and two threaded rings, is reported, as well as some of its complexing properties toward given guests. Two rings rigidly attached to porphyrins are threaded by a stiff rod incorporating two 2,2′-bipyridine-like chelates, the threading process being driven by two Cu(I) atoms acting as templates. A double-stoppering reaction based on click chemistry leads to the copper-complexed [3]rotaxane in which the rings are located close to the central part of the thread and the distance between the two porphyrin plates is short. Removal of the two Cu(I) cations releases the two rings which are now free to move along and around the thread. In these two states of the [3]rotaxane, free and complexed with copper, the two zinc(II) porphyrins attached to the rings can bind different ditopic guests bearing pyridyl groups or amines as terminal functions. UV−visible and NMR DOSY experiments were realized with guests of different sizes, and the association constants were determined. The free [3]rotaxane is both a strong and highly adaptable receptor with high stability constants for the host/guest complexes, log *K* being in the range of 6.3−7.5 for guests with a length varying between 2.8 and 18 Å. The copper-complexed [3]rotaxane is still a good receptor for small guests due to an entropic gain for this preorganized molecule compared to the free [3]rotaxane, but it is a less strong receptor for guests which do not fit the short distance between the two porphyrins.

- Coupled Growth and Division of Model Protocell Membranes
  Zhu, T. F.; Szostak, J. W. *J. Am. Chem. Soc.* **2009**, *131*, 5705–5713.
  Abstract:



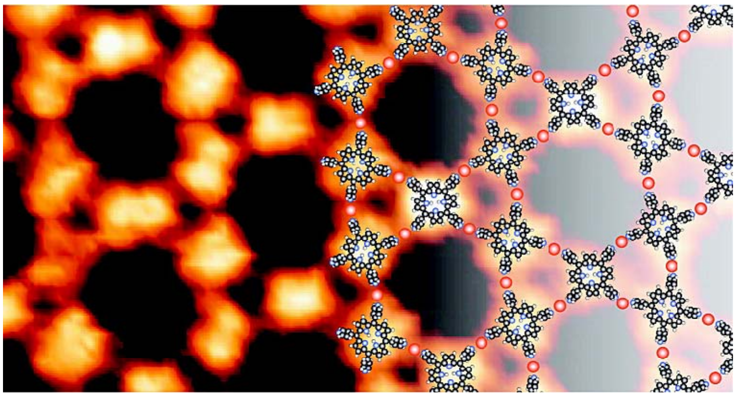
The generation of synthetic forms of cellular life requires solutions to the problem of how biological processes such as cyclic growth and division could emerge from purely physical and chemical systems. Small unilamellar fatty acid vesicles grow when fed with fatty acid micelles and can be forced to divide by extrusion, but this artificial division process results in significant loss of protocell contents during each division cycle. Here we describe a simple and efficient pathway for model protocell membrane growth and division. The growth of large multilamellar fatty acid vesicles fed with fatty acid micelles, in a solution where solute permeation across the membranes is slow, results in the transformation of initially spherical vesicles into long thread-like vesicles, a process driven by the transient imbalance between surface area and volume growth. Modest shear forces are then sufficient to cause the thread-like vesicles to divide into multiple daughter vesicles without loss of internal contents. In an environment of gentle shear, protocell growth and division are thus coupled processes. We show that model protocells can proceed through multiple cycles of reproduction. Encapsulated RNA molecules, representing a primitive genome, are distributed to the daughter vesicles. Our observations bring us closer to the laboratory synthesis of a complete protocell consisting of a self-replicating genome and a self-replicating membrane compartment. In addition, the robustness and simplicity of this pathway suggests that similar processes might have occurred under the prebiotic conditions of the early Earth.

- Reversible Transformation between Rings and Coils in a Dynamic Hydrogen-Bonded Self-Assembly
  Yagai, S.; Kubota, S.; Saito, H.; Unoike, K.; Karatsu, T.; Kitamura, A.; Ajayaghosh, A.; Kanesato, M.; Kikkawa, Y. *J. Am. Chem. Soc.* **2009**, *131*, 5408–5410.
  <u>Abstract:</u>



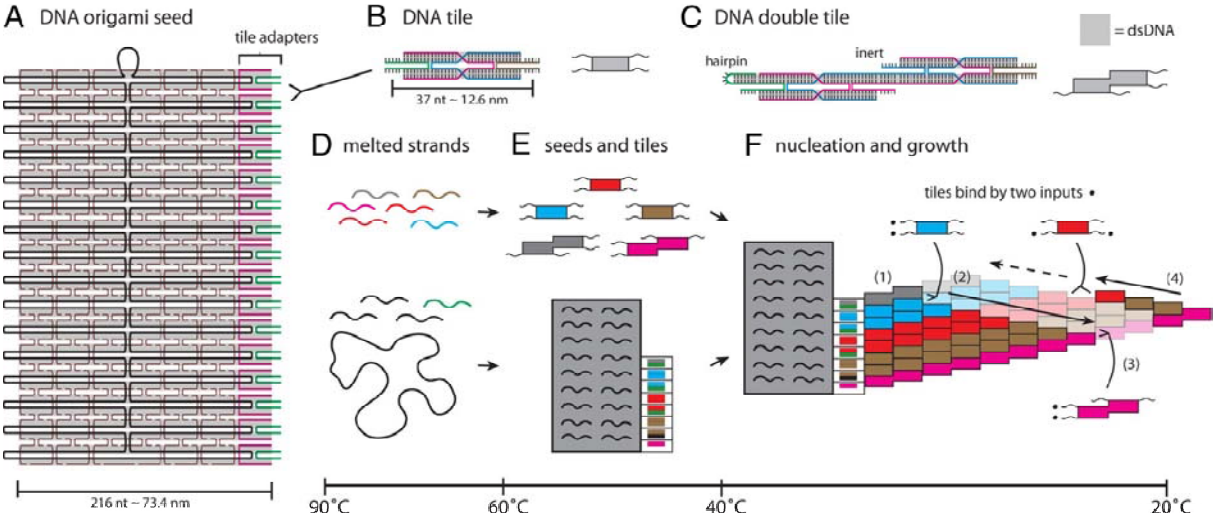
Several proteins, such as tobacco mosaic virus coat protein and the β protein of the bacteriophage λ, are known to exhibit unique dynamic self-organization processes involving ring-shaped and extended helical nanostructures triggered by chemical stimuli. However, transformation of rings into coils as observed in biological assemblies has never been realized with synthetic molecular building blocks. Oligo(*p*-phenylenevinylene) functionalized on one end with barbituric acid and on the other end with aliphatic tails self-organizes in aliphatic solvents to form nanorings through hydrogen-bonding and π-stacking interactions. Upon an increase in concentration, the nanorings transform into rodlike nanostructures, which are considered to be formed through helically coiled objects consisting of quasi-one-dimensional fibers.

- Porphyrin-Based Two-Dimensional Coordination Kagome Lattice Self-Assembled on a Au(111) Surface
  Shi, Z.; Lin, N. *J. Am. Chem. Soc.* **2009**, *131*, 5376–5377.
  <u>Abstract:</u>



A two-dimensional network of metal-coordinated Kagome lattice has been self-assembled by free-base tetrapyridyl porphyrin molecules on a Au(111) surface. Au ad-atoms offered by the surface coordinate the pyridyl functions of the neighboring porphyrins in a 2-fold linear coordination. Comparison of the self-assemblies of the same molecules on various surfaces (Au, Ag, and Cu) underlines the fact that both structural and chemical characteristics of surfaces play important roles in determining the supramolecular adlayer structures.

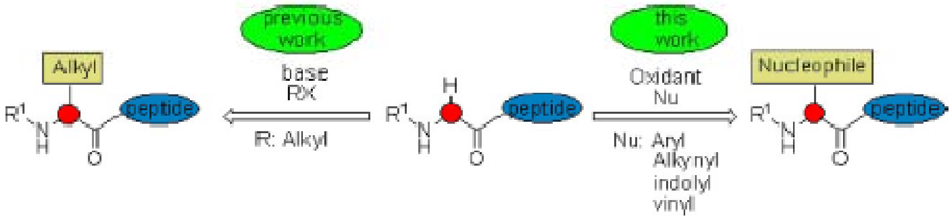
- An information-bearing seed for nucleating algorithmic self-assembly
  Barish, R. D.; Schulman, R.; Rothemund, P. W. K.; Winfree, E. *Proc. Nat. Acad. Sci.* **2009**, *106*, 6054–6059.
  Abstract:



Self-assembly creates natural mineral, chemical, and biological structures of great complexity. Often, the same starting materials have the potential to form an infinite variety of distinct structures; information in a seed molecule can determine which form is grown as well as where and when. These phenomena can be exploited to program the growth of complex supramolecular structures, as demonstrated by the algorithmic self-assembly of DNA tiles. However, the lack of effective seeds has limited the reliability and yield of algorithmic crystals. Here, we present a programmable DNA origami seed that can display up to 32 distinct binding sites and demonstrate the use of seeds to nucleate three types of algorithmic crystals. In the simplest case, the starting materials are a set of tiles that can form crystalline ribbons of any width; the seed directs assembly of a chosen width with >90% yield. Increased structural diversity is obtained by using tiles that copy a binary string from layer to layer; the seed specifies the initial string and triggers growth under near-optimal conditions where the bit copying error rate is <0.2%. Increased structural complexity is achieved by using tiles

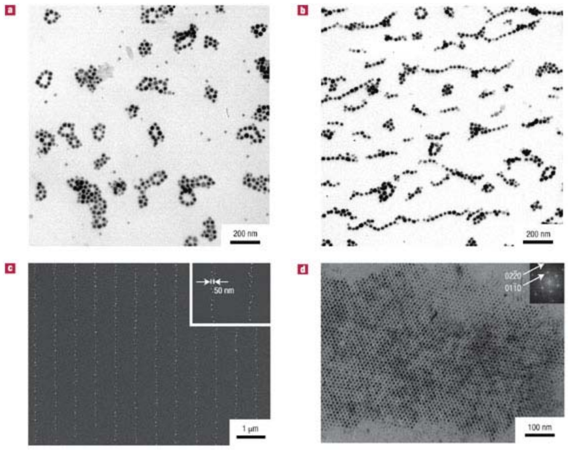
that generate a binary counting pattern; the seed specifies the initial value for the counter. Self-assembly proceeds in a one-pot annealing reaction involving up to 300 DNA strands containing >17 kb of sequence information. In sum, this work demonstrates how DNA origami seeds enable the easy, high-yield, low-error-rate growth of algorithmic crystals as a route toward programmable bottom-up fabrication.

- Site-specific C-functionalization of free-(NH) peptides and glycine derivatives via direct C–H bond functionalization
  Zhao, L.; Baslé, O.; Li, C.-J. *Proc. Nat. Acad. Sci.* **2009**, *106*, 4106–4111.
  Abstract:



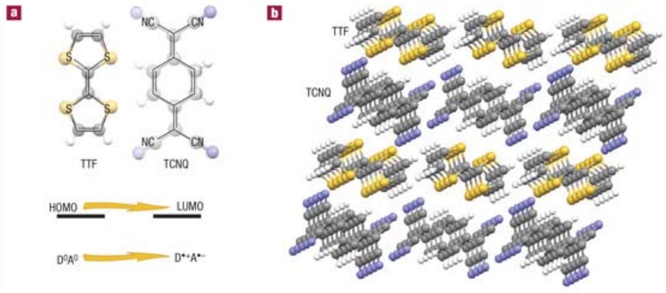
A copper-catalyzed α-functionalization of glycine derivatives and short peptides with nucleophiles is described. The present method provides ways to introduce functionalities such as aryl, vinyl, alkynyl, or indolyl specifically to the terminal glycine moieties of small peptides, which are normally difficult in peptide modifications. Furthermore, on functionalization, the configurations of other stereocenters in the peptides could be maintained. Because the functionalized peptides could easily be deprotected and carried onto the next coupling process, our approach provides a useful tool for the peptide-based biological research.

- The role of interparticle and external forces in nanoparticle assembly
  Min, Y.; Akbulut, M.; Kristiansen, K.; Golan, Y.; Israelachvili, J. *Nature Materials* **2008**, *7*, 527-538.
  Abstract:



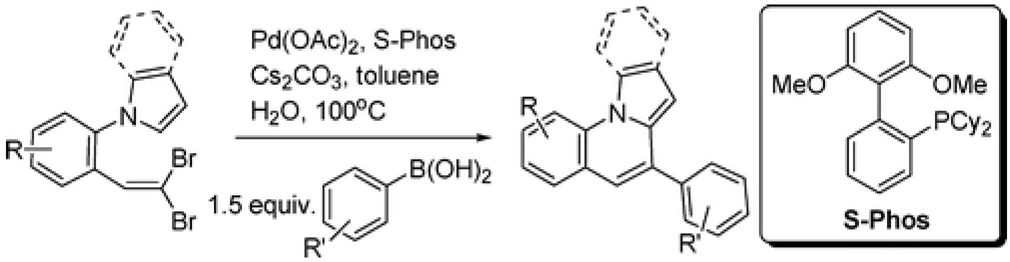
The past 20 years have witnessed simultaneous multidisciplinary explosions in experimental techniques for synthesizing new materials, measuring and manipulating nanoscale structures, understanding biological processes at the nanoscale, and carrying out large-scale computations of many-atom and complex macromolecular systems. These advances have led to the new disciplines of nanoscience and nanoengineering. For reasons that are discussed here, most nanoparticles do not 'self-assemble' into their thermodynamically lowest energy state, and require an input of energy or external forces to 'direct' them into particular structures or assemblies. We discuss why and how a combination of self- and directed-assembly processes, involving interparticle and externally applied forces, can be applied to produce desired nanostructured materials.

- Metallic conduction at organic charge-transfer interfaces
  Alves, H.; Molinari, A. S.; Xie, H.; Morpurgo, A. F. *Nature Materials* **2008**, *7*, 574-580.
  Abstract:



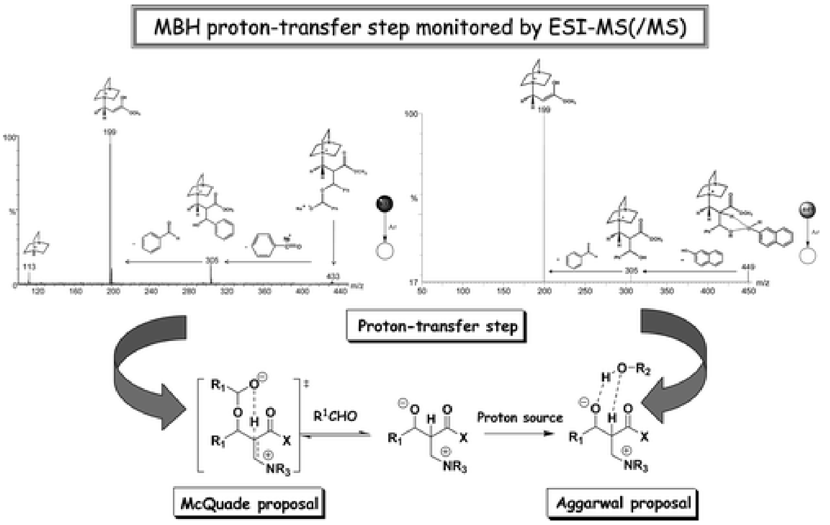
The electronic properties of interfaces between two different solids can differ strikingly from those of the constituent materials. For instance, metallic conductivity—and even superconductivity—have recently been discovered at interfaces formed by insulating transition-metal oxides. Here, we investigate interfaces between crystals of conjugated organic molecules, which are large-gap undoped semiconductors, that is, essentially insulators. We find that highly conducting interfaces can be realized with resistivity ranging from 1 to 30 kΩ per square, and that, for the best samples, the temperature dependence of the conductivity is metallic. The observed electrical conduction originates from a large transfer of charge between the two crystals that takes place at the interface, on a molecular scale. As the interface assembly process is simple and can be applied to crystals of virtually any conjugated molecule, the conducting interfaces described here represent the first examples of a new class of electronic systems.

- Tandem Pd-Catalyzed Double C-C Bond Formation: Effect of Water
  Chai, D. I.; and Lautens, M. *J. Org. Chem.* **2009**, *74*, 3054–3061.
  Abstract:



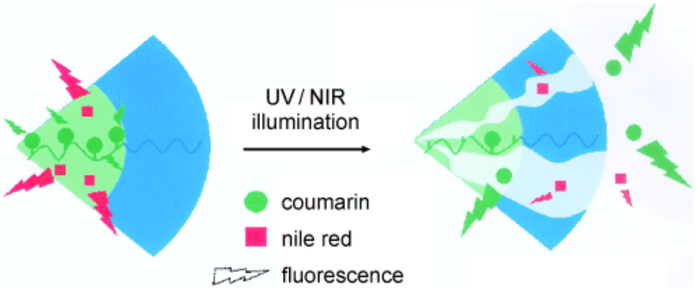
A highly efficient water-accelerated palladium-catalyzed reaction of *gem*-dibromoolefins with a boronic acid via a tandem Suzuki-Miyaura coupling and direct arylation is reported. A wide range of aryl, alkenyl, and alkyl boronic acids, as well as a variety of substitution patterns on the phenyl ring, are tolerated. Additionally, mechanistic studies were conducted to ascertain the order of the couplings as well as the role(s) of water. Results from this study indicate that the major pathway is a Suzuki-Miyaura coupling/direct arylation sequence and that water accelerates the Pd(0) formation and Suzuki-Miyaura coupling.

- Dualistic Nature of the Mechanism of the Morita-Baylis-Hillman Reaction Probed by Electrospray Ionization Mass Spectrometry
  Amarante, G. W.; Milagre, H. M. S. ; Vaz, B. G.; VilachaB. R. V.; Eberlin, M. N.; Coelho, F. *J. Org. Chem.* **2009**, *74*, 3031–3037.
  Abstract:



The Morita-Baylis-Hillman (MBH) reaction allows chemists to form new σ C-C bonds in a single-step straightforward manner and thus to construct densely functionalized molecules for further chemical manipulation. Using electrospray ionization for transferring ions directly from solution to the gas phase, and mass (and tandem mass) spectrometry for mass and structural assignments, new key intermediates for the rate-determining step of the MBH reaction have been successfully intercepted and structurally characterized. These ESI-MS data provide experimental evidence supporting recent suggestions, based on kinetic experiments and theoretical calculations, for the dualist nature of the proton-transfer step of the MBH mechanism.

- A New Two-Photon-Sensitive Block Copolymer Nanocarrier
  Babin, J.; Pelletier, M.; Lepage, M.; Allard, J.-F.; Morris, D.; Zhao, Y. *Angew. Chem. Int. Ed.* **2009,** *48*, 3329 –3332.
  Abstract:

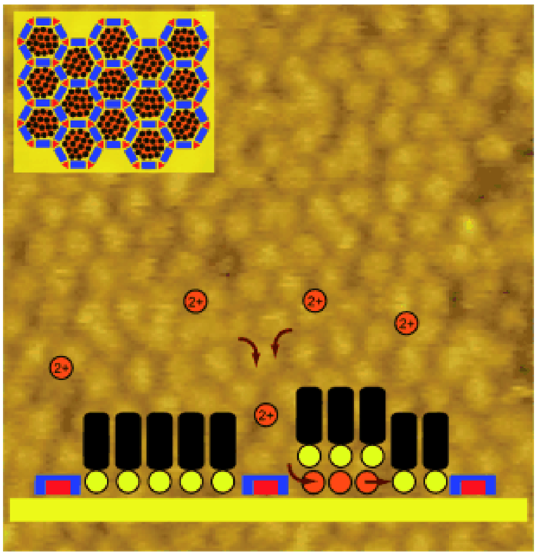


Easily disrupted: Micelles of a new amphiphilic block copolymer that bear coumarin groups are sensitive to near infrared light by two-photon absorption of the chromophore. Disruption of the micelles under irradiation at 794 nm results in release of both photocleaved coumarin and encapsulated nile red from the hydrophobic core of micelle into aqueous solution, which results in opposing changes in fluorescence emission intensity.

- A Supramolecular Hydrogen-Bonded Network as a Diffusion Barrierfor Metal adatoms

Silien, C.; Räisänen, M. T.; Buck, M. *Angew. Chem. Int. Ed.* **2009**, *48*, 3349 –3352.

Abstract:



Confined in a molecular corral: A supramolecular network changes the mechanism by which underpotential deposition (UPD) of copper proceeds on a gold electrode modified by a self-assembled monolayer (SAM). Lateral diffusion of Cu adatoms is suppressed between adjacent cells of a network/SAM hybrid structure. Instead, UPD occurs by direct deposition into the SAM filled pores of the network, where the Cu adatoms are confined.