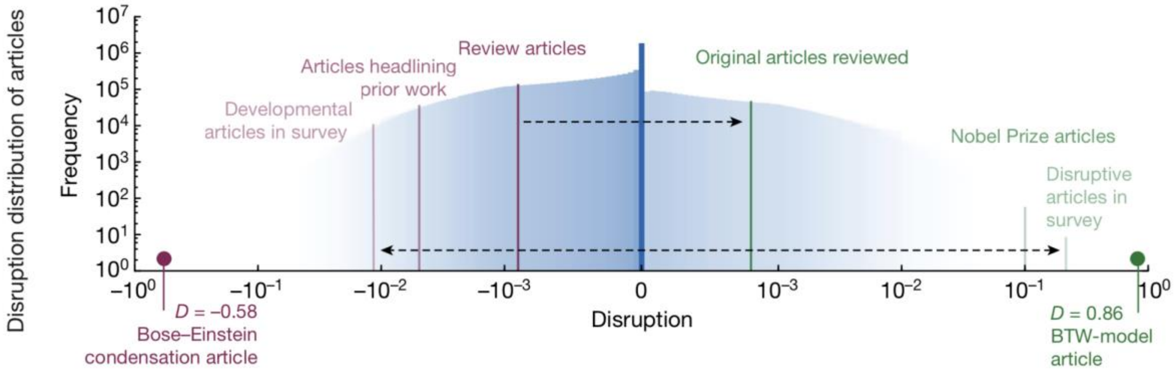
Large Teams Develop and Small Teams Disrupt Science and Technology

Wu, L.; Wang, D.; Evans, J. A.* *Nature* **2019**, *566*, 378–382.

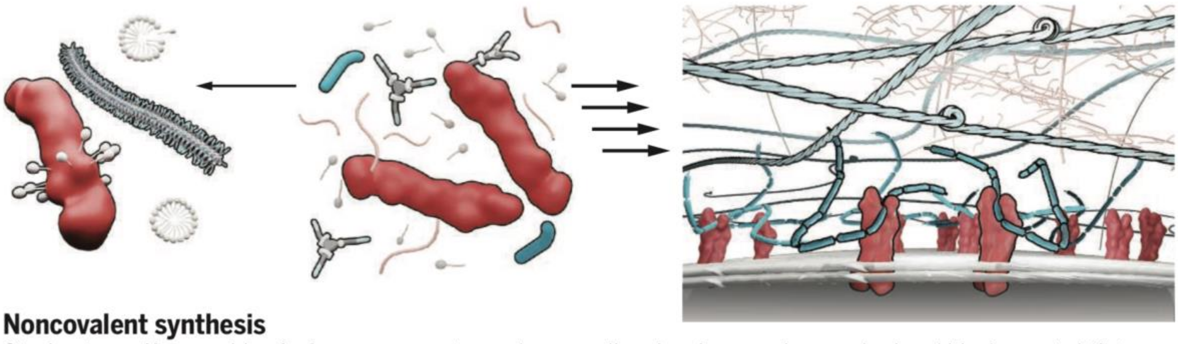


One of the most universal trends in science and technology today is the growth of large teams in all areas, as solitary researchers and small teams diminish in prevalence. Increases in team size have been attributed to the specialization of scientific activities, improvements in communication technology, or the complexity of modern problems that require interdisciplinary solutions. This shift in team size raises the question of whether and how the character of the science and technology produced by large teams differs from that of small teams. **Here we analyse more than 65 million papers, patents and software products that span the period 1954–2014, and demonstrate that across this period smaller teams have tended to disrupt science and technology with new ideas and opportunities, whereas larger teams have tended to develop existing ones.** Work from larger teams builds on more- recent and popular developments, and attention to their work comes immediately. By contrast, contributions by smaller teams search more deeply into the past, are viewed as disruptive to science and technology and succeed further into the future—if at all. Observed differences between small and large teams are magnified for higher- impact work, with small teams known for disruptive work and large teams for developing work. Differences in topic and research design account for a small part of the relationship between team size and disruption; most of the effect occurs at the level of the individual, as people move between smaller and larger teams. **These results demonstrate that both small and large teams are essential to a flourishing ecology of science and technology**, and suggest that, to achieve this, science policies should aim to support a diversity of team sizes.

Comment: I cannot promise that the paper is easy to read, quite the contrary in fact, but the conclusions are simple to understand and rather obvious to be honest. Small groups produce original science and big groups develop ideas and techniques to maturity. The reasons are probably that small groups need to do something amazing to ever get published, which can be taken up by big groups that are the only ones to have the resources to really explore any one subject in detail. Perfect picture.

The construction of supramolecular systems

Vantomme, G.; Meijer, E. W.* *Science* **2019**, *363*, 1396–1397.



Noncovalent synthesis
Single-step self-assembly of a few components, such as small molecules or polymers (red and blue), must shift to multistep synthetic strategies to mimic complex biological structures such as the extracellular matrix.

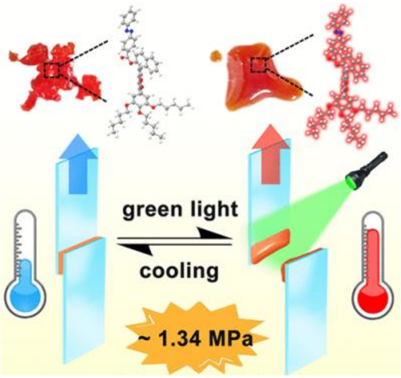
Self-assembly by intermolecular noncovalent interactions directed by self-recognition created the field of supramolecular chemistry. **However, the word “self” appears to limit this field to mixing components in one assembly step where most of the complexity is inherent in the covalently synthesized reactants**, rather than the result of a series of assembly steps that build more complex structures in reproducible procedures. The paradigm shift in supramolecular chemistry that we propose is the building of multicomponent systems following a multistep pathway—the emergence of molecular complexity (see the figure). The latter is not only directed by the information stored in the covalent framework of the components, but also controlled by the kinetics and thermodynamics of the reaction pathways selected in processing this information.

Although noncovalent synthesis was quoted by Whitesides and Reinhoudt in the 1990s, it has never been broadly accepted nor used. **The main reason comes from the difficulty in manipulating the reactivity of the noncovalent bond**, the dynamic nature of the structures formed, and a lack of physical organic characterization of the individual assembly steps. The noncovalent interactions involve forces weaker than their covalent counterparts with a larger participation of entropic energy, which makes the control of the structure-energy balance more delicate.

Comment: This is very lazy of me, to propose a perspective paper. But I like this one, for obvious reason, because it highlights rather nicely this big issue of moving away from self-assembly (understood as mix, shake, and voilà) towards actual non-covalent synthesis. And for any more details, please read the paper, it is only 2 pages long!

Green-Light-Triggered Phase Transition of Azobenzene Derivatives toward Reversible Adhesives

Wu, Z.; Ji, C.; Zhao, X.; Han, Y.; Müllen, K.; Pan, K.; Yin, M.* *J. Am. Chem. Soc.* ***2019**, 141* *(18), 7385–7390*.



Studies on the azobenzene derivative based phase transitions mostly rely on photoisomerization, which require a long time to spontaneously revert back. Here we show a photothermal-driven solid-to-liquid transition and fast reversion of azobenzene derivatives. Owing to the aggregation of suitably substituted azobenzenes, **solid-to-liquid transitions** can be **induced by photothermal effects under irradiation with green light**. The liquid-state azobenzene derivatives spontaneously **solidify again within 2 min** due to **heat release** in a purely physical fashion. One thus obtains a perfectly reversible adhesion with a strength as high as that of commercial materials. Our work affords a novel concept to construct reversible adhesives via phase transitions of organic compounds induced by light.

Comment: This paper allows us to get a better understanding of the means of tuning of the azobenzene absorption wavelength. However, in this case, the presence of this particular photoswitching unit is not necessary since it is sufficient to heat the sample up to ~37°C in order to observe the same solid-to-liquid transition. The azobenzene moiety is just used to induced a photo-thermal effect and it could easily be replaced by another dyeing agent.

Formation of a Supramolecular Polymeric Adhesive via Water–Participant Hydrogen Bond Formation.

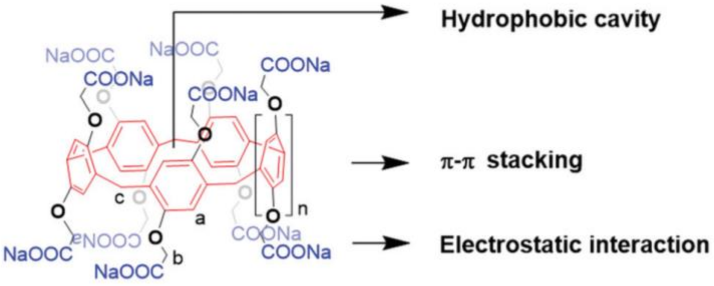
Zhang, Q.; Li, T.; Duan, A.; Dong, S.*; Zhao, W.*; Stang, P. J.* *J. Am. Chem. Soc.* **2019**, *ASAP*.

A **supramolecular polymeric adhesive** was prepared from non-viscous, non-polymeric materials by **water–participant hydrogen bonds**. **Pt–pyridine coordination** and **water–crown ether hydrogen bonding** combine to effect the supramolecular polymerization. The supramolecular polymeric adhesive displays **strong**, **reversible adhesion to hydrophilic surfaces**, a property that forecasts the application of hydrogen bonding in advanced supramolecular materials.

Comment: This second paper is also related to polymeric adhesive although the obtained material is certainly less practical as it relies on the presence of water. What I find fascinating in this article is how the authors managed to use the power of hydrogen bonds. If I had only seen the molecular structure of the monomer, I would have never guessed that it would form a polymer in the presence of water.

Carboxylated Pillar[*n*]Arene (n = 5–7) Host Molecules: High Affinity and Selective Binding in Water

Liu, Y.; Zhou, F.; Yang, F.; Ma, D.* *Org. Biomol. Chem.* **2019**, *17*, 5106–5111.



Water-soluble carboxylated pillar[*n*]arenes (n = 5–7) or **WP*n***s were discovered to be high affinity host molecules with selective binding for different guests based on a systematic investigation. We chose 22 dyes or guests and determined the value of K_a for 51 supramolecular complexes. It was discovered that the **electrostatic interactions, π–π stacking and hydrophobic effect were the driving force** for high affinity supramolecular encapsulation. **WP*n***s had selective binding toward suitable guests based on their sizes and molecular structures. Based on the above discovery, a guest (guest 21) was designed, which bound with **WP7** 3.3-fold tighter compared to methyl viologen.

Comment: In this paper, the authors present a relatively complete analytical study of several hydrosoluble pillar[*n*]arenes. They determined the association constants of these hosts with various guests to conclude on the importance of hydrophobic forces, π–π stacking and electrostatic interactions for efficient binding, and they used these results to design a guest with a high binding affinity. **I would not rely too much on their quantitative data**, however; even though they say that the results they obtained by UV-Vis –which they mainly used here because it is fast– are quite close to the ones obtained by ITC –which is usually used because of the reliability– a closer look to the data reveals that ITC gives values three times higher to the ones obtained by UV-Vis.

Proactively Modulating Mechanical Behaviors of Materials at Multiscale for Mechano-Adaptable Devices

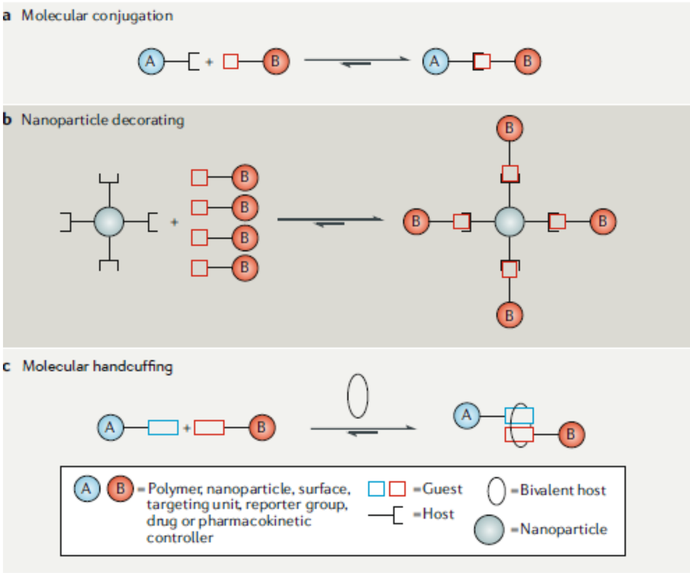
Chen, G.; Cui, Y.; Chen, X.* *Chem. Soc. Rev.* **2019**, *48*, 1434–1447.

How materials behave when subjected to mechanical stresses is studied by mechanics of materials. However, the application of flexible and stretchable devices exposes materials to dynamic mechanical environments. Therefore, **mechano-adaptable materials and devices that can respond as pre-designed have been explored**. There are two main ways to proactively modulate mechanical behaviors for materials, which involve molecular design and structural design. Molecular design has effectively integrated mechanically sensitive groups into synthetic materials for anticipated mechano-response. Structural design has broadened the boundary of conventional materials, generating mechanical metamaterials at multiscale with unique mechanical properties. Furthermore, molecular, structural plus systematic design for the application of mechano-adaptable devices have realized better electrical performance, human interaction, long-term sustainability, and even higher efficiency**. Various devices based on design ideas are summarized and future challenges for proactively modulating mechanical behaviors of mechano-adaptable devices are discussed.**

Comment: We, as living systems, are mainly composed of stretchable materials that are sensitive to external mechanical forces. Thus, it seems obvious that material scientists are willing to achieve similar synthetic materials. This review presents a clear overview of this topic. First, **mechanically-responsive molecules are presented**, such as spiropyran or molecules containing disulfide bonds, to correlate the molecular design to the functions of the material. Then, **the structures of metamaterials** are presented –an interesting topic on its own, in my opinion– to show their importance for the next generation of smart materials. Finally, **a few examples of materials are discussed.** If you are interested in such smart mechanoresponsive materials, this review is a good start.

Molecular conjugation using non- covalent click chemistry

Schreiber, C. L.; Smith, B. D.* *Nat. Rev. Chem*, **2019**, *ASAP*

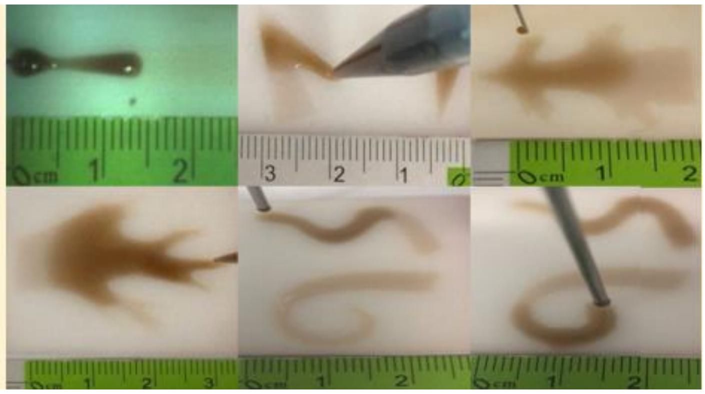


Molecular conjugation refers to methods used in biomedicine, advanced materials and nanotechnology to link two partners — from small molecules to large and sometimes functionally complex biopolymers. The methods ideally have a broad structural scope, proceed under very mild conditions (including in H2O), occur at a rapid rate and in quantitative yield with no by- products, enable bioorthogonal reactivity and have zero toxicity. Over the past two decades, the field of click chemistry has emerged to afford us new and efficient methods of molecular conjugation. These methods are based on chemical reactions that produce permanently linked conjugates, and we refer to this field here as covalent click chemistry. Alternatively, if molecular conjugation is undertaken using a **pair of complementary molecular recognition partners that associate strongly and selectively to form a thermodynamically stable non- covalent complex**, then we refer to this strategy as **non- covalent click chemistry**. This Perspective is concerned with this latter approach and highlights two distinct applications of non- covalent click chemistry in molecular conjugation: the **pre- assembly of molecular conjugates** or surface- coated nanoparticles and the **in situ capture of tagged biomolecular targets** for imaging or analysis.

Comment: Click chemistry, involving the formation of covalent bonds, has been carefully explored over the past two decades. It is interesting to see that this approach can be extended to non-covalent bond formation, using guest-host pairs, in examples such as proteins or synthetic macrocycles. While the covalent chemistry leads to high stable structures, the non-covalent approach forms supramolecular objects that are less stable. A good idea would be then to have a synergic approach, employing the fast supramolecular association, and the high stability induced by covalent bonds. This approach is based on the same concept than our double dynamic polyurethanes.

Directional Transport Behavior of Droplets on Wedge-Shaped Functional Surfaces

Liu, M.; Yao, Y.; Yang, Y.; Peng. Z.*; Chen, S.* *J. Phys. Chem. C*, **2019**, *ASAP*



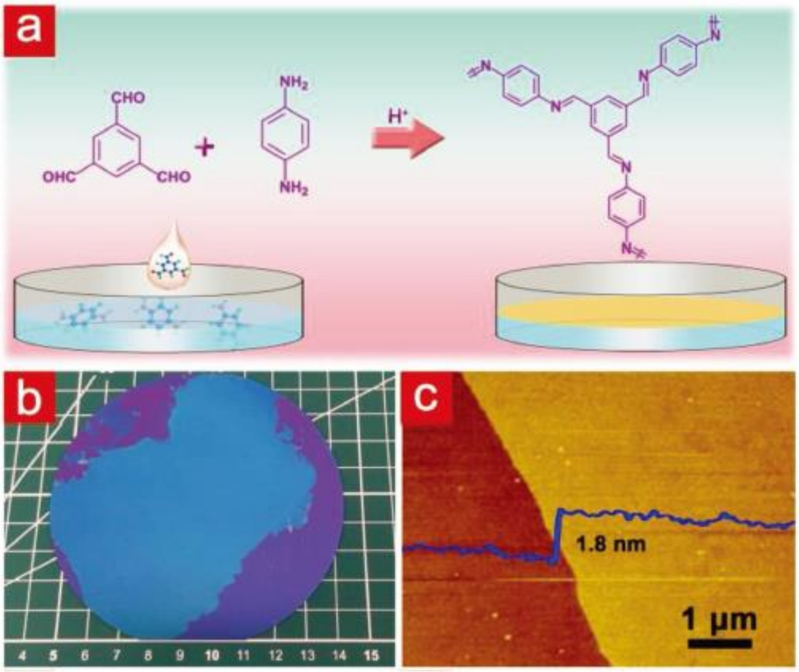
Functional surfaces attract considerable research interest because of many practical applications. A wedge-shaped functional surface is a typical example, which can be designed to achieve selfcleaning, water collection, heat dissipation, or separation of mixed droplets, depending on the wettability of wedge-shaped areas inset in a hydrophobic substrate surface. In this work, a simple technology is proposed to achieve a **wedge-shaped functional surface, which could realize directional transport of droplets**. It is found that the transport behavior of droplets depends significantly on the wedge angle, the static contact angle of the wedge-shaped hydrophilic region, and the droplet volume. An approximate theoretical model is established, which can predict the **most important parameter, that is, the transport displacement**. The theoretical prediction can be verified experimentally. Furthermore, an interesting phenomenon of multistep acceleration is also observed in the transport process. With the aid of the present simple technology, several functional surfaces for the directional transport of droplets can be well designed, including root-like patterned surfaces and nonlinear spiral- or curve-patterned surfaces. All the results should be helpful for the flexible design of functional surfaces for droplet transport in microfluidics or lab-on-a-chip applications.

Comment: This paper describes the synthesis of wedges-shaped functional surfaces allowing directional transport of droplets. The advantage here is the ease of production of such a material, by 3D-printing of photo-active polymers, leading to a wide variety of obtained surfaces.

Furthermore, a well-described theoretical model fits with the experimental observations, allowing to predict the droplet displacement according to several parameters, such as the droplet volume.

A Robust Nonvolatile Resistive Memory Device Based on a Freestanding Ultrathin 2D Imine Polymer Film

Liu, J.; Yang, F.; Cao, L.; Li, B.; Yuan, K.; Lei, S.*; Hu, W.* *Adv. Mater.* **2019**, 1902264.

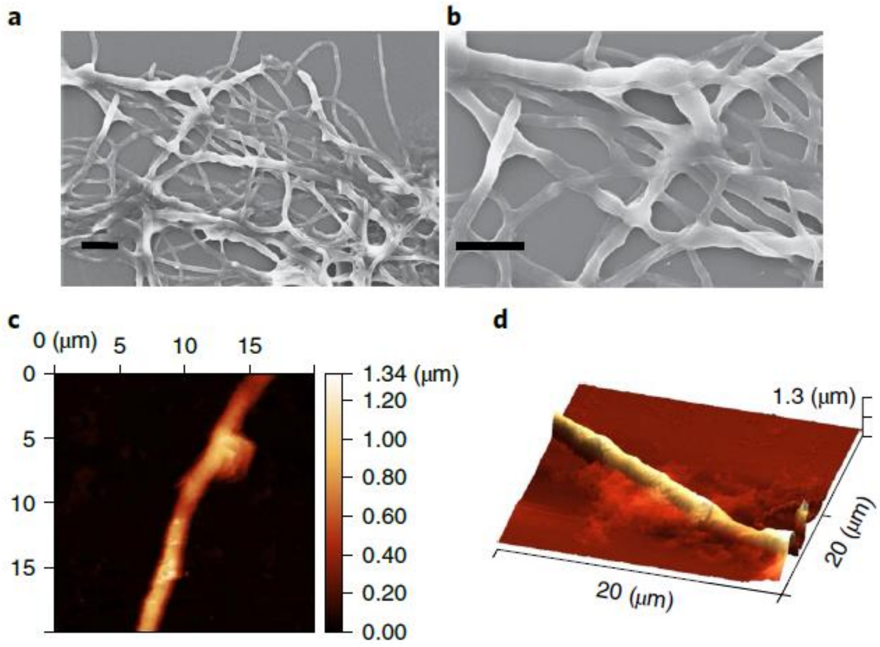


Here, the synthesis of a wafer-scale ultrathin 2D imine polymer (2DP) film with controllable thickness from simple benzene-1,3,5-tricarbaldehyde (BTA) and p-phenylenediamine (PDA) building blocks is reported using a Schiff base polycondensation reaction at the air–water interface. The synthesized freestanding 2DP films are porous, insulating, and more importantly, covalently linked, which is ideally suited for nonvolatile memristors that use a conductive filament mechanism. These devices exhibit excellent switching performance with high reliability and reproducibility, with on/off ratios in the range of 10^2 to 10^5 depending on the thickness of the film. In addition, the endurance and data retention capability of 2DP-based nonvolatile resistive memristors are up to 200 cycles and 8×10^4 s under constant voltage stress at 0.1 V. The intrinsic flexibility of the covalent organic polymer enables the fabrication of a flexible memory device on a polyimide film, which exhibits as reliable memory performance as that on the rigid substrate. Moreover, the 2DP-based memory device shows outstanding thermal stability and organic solvent resistance, which are desirable properties for applications in wearable devices.

Comment: There are many examples of film that occur at the liquid-liquid interface, including supramolecular and covalent polymers. In principle, the supramolecular polymer films are fragile due to the weak non-colavent interaction. This paper demonstrates a 2D imine polymer film which is robust and exhibits non-volatile resistive memory behavior.

Rigid helical-like assemblies from a self-aggregating tripeptide

Bera, S.; Mondal, S.; Xue, B.; Shimon, L. J. W.; Cao, Y.; Gazit, E.* *Nat. Mater.* *2019*, **18**, 503.

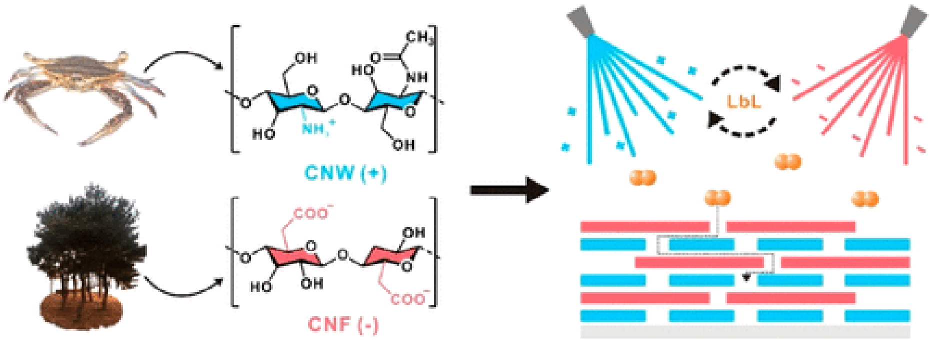


The structural versatility, biocompatibility and dynamic range of the mechanical properties of protein materials have been explored in functional biomaterials for a wide array of biotechnology applications. Typically, such materials are made from self-assembled peptides with a predominant β-sheet structure, a common structural motif in silk and amyloid fibrils. However, collagen, the most abundant protein in mammals, is based on a helical arrangement. Here we show that Pro Phe-Phe, the most aggregation-prone tripeptide of natural amino acids, assembles into a helical-like sheet that is stabilized by the dry hydrophobic interfaces of Phe residues. This architecture resembles that of the functional PSMα3 amyloid, highlighting the role of dry helical interfaces as a core structural motif in amyloids. Proline replacement by hydroxyproline, a major constituent of collagen, generates minimal helical-like assemblies with enhanced mechanical rigidity. These results establish a framework for designing functional biomaterials based on ultrashort helical protein elements.

Comment: The self-assembly of this tripeptide is a novel structure, which was never reported for any short peptides. I am interested in this kind of supramolecular structure because I always get fibers for my samples. In this paper, the authors clearly explain the mechanism and its properties.

Crab-on-a-Tree: All Bio-Renewable, Optical-and-Radio Frequency Transparent Barrier Nanocoating for Food Packaging

Kim, T.; Tran, T. H.; Hwang, S. Y.; Park, J.; Oh, D. X.; Kim, B.-S.* *ACS Nano*, **2019**, *13*, 3796-3805

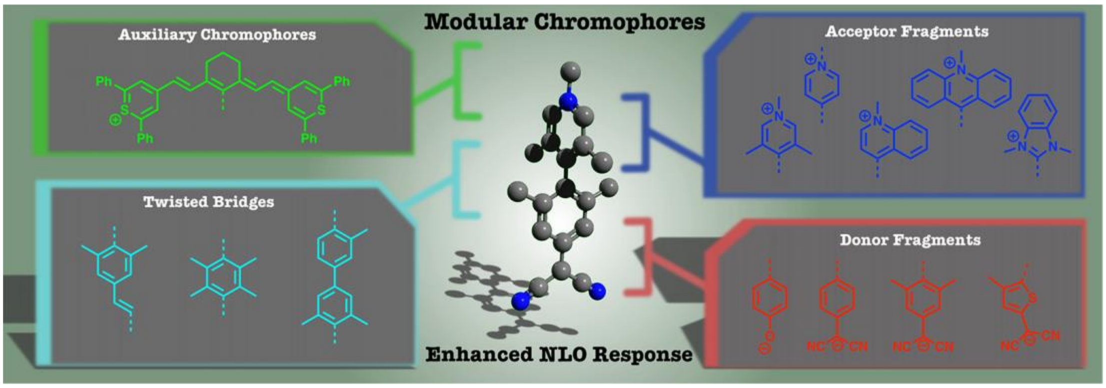


Plastic packaging effectively protects foods from mechanical, microbial, and chemical damage, but oxygen can still permeate these plastics, degrading foods. Improving the gas barrier usually requires metallic or halogenated polymeric coatings; however, both cause environmental concerns and metallic coatings block visible light and electromagnetic signals. This paper reports a design of a **highly flexible, visible light and radio frequency transparent coating on commercial PET film.** Nanoscale blending was achieved between negatively charged cellulose nanofibers and positively charged chitin nanowhiskers by employing spray-assisted **layer-by-layer** assembly. Synergetic interplay between these highly crystalline nanomaterials results in a flexible film with superior barrier characteristics. The oxygen transmission rate was below 0.5 mLm-2day-1. Moreover, this coating maintains its performance even when exposed to common hazards such as bending stress and hydration. The coating also notably reduces the haziness of PET with a negligible loss of transparency and provides effective inhibition of antibacterial growth. This "crab-on-a-tree" nanocoating holds high potential for **bio-renewable** and optical-and-radio frequency transparent packaging applications.

Comment: This article addresses an important –and urgent– problem on food packaging. Although I think we should strive to reduce as much as possible all plastic packings, for some foods it is necessary to keep it in a wrapper in order to increase its shelf life and thereby reduce spoilage and food waste (e.g. cucumbers). The importance of their research is thus clear. Secondly, they use the lbl technique, which was invented at the ICS by Gero Decher.

A Twist on Nonlinear Optics: Understanding the Unique Response of π-Twisted Chromophores

Lou, A. J.-T.; Marks, T. J.**Acc. Chem. Res.*, **2019**, *52*, 1428-14385

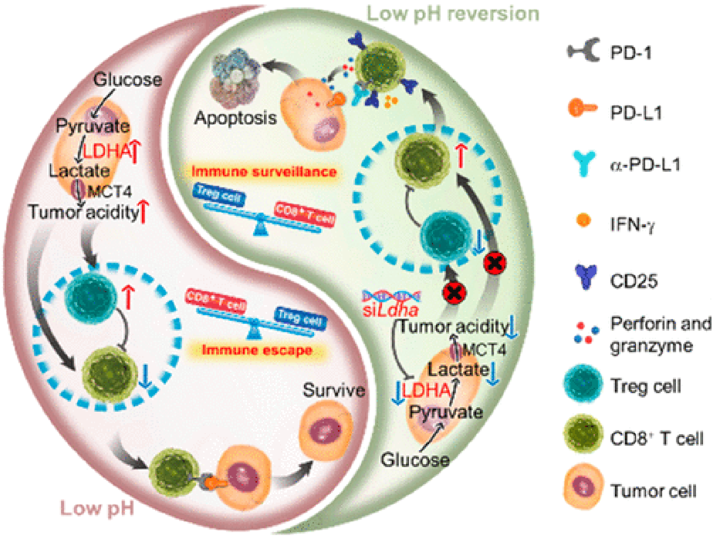


Materials with large nonlinear optical (NLO) response have the ability to manipulate the frequency and phase of incident light and exhibit phenomena that form the basis of modern telecommunication systems. In molecule-based materials, the second- and third-order NLO performance is related to the hyperpolarizability (β) and second hyperpolarizability (γ) of the constituent molecules. The search for higher β materials is driven by the desire to keep pace with expanding demand for high speed data transmission, while discovery of high γ chromophores is crucial for the development of emergent photonic technologies reliant on manipulation of "light-with-light". For decades, it was believed that for highest performance, organic NLO materials must be composed of planar π-system chromophores, and much exploratory research focused on subtle molecular modifications, which generally yielded incremental increases in μβ, where μ is the molecular dipole moment. The surprising recent discovery that **twisted π-system chromophores can exhibit dramatically higher β values than their planar analogues** has revealed a new design paradigm and stimulated the development of high performance **twisted intramolecular charge transfer (TICT) chromophores, which are composed of electron-donating and electron-accepting π-substituents joined by a sterically constrained twisted biaryl fragment**. In such chromophores, the twisting of the π-system enforces charge separation in the electronic ground state, leading to large dipole moments and low-lying charge-transfer excitations. This unique electronic structure forms the basis for enhanced NLO response, with an archetypal TICT chromophore, TMC-2, exhibiting very large second- ($\mu\beta = 24\,000 \times 10^{-48}$ esu) and third-order ($\gamma = 1.4 \times 10^{-33}$ esu) metrics in dilute low-polarity solutions. This Account summarizes several approaches to enhance μβ in various environments, including (1) manipulating the biaryl torsional angle, (2) modifying the electron accepting fragment, (3) extending conjugation, (4) adding multiple twisted fragments, (5) modifying chromophore side chains, and (6) tuning the chromophore environment. Another set of modifications is explored to enhance γ, including (1) coupling to a cyanine dye to hybridize the cyanine and TICT orbitals, (2) manipulating the donor and acceptor group identity. The extensive modifications described above yield a detailed understanding of TICT chromophore molecular NLO response and unambiguous evidence that such chromophores have the potential to revolutionize organic electro-optics.

Comment: As mentioned in the abstract, it was recently discovered that twisted chromophores are able to enhance β values significantly. Up to now an overview and systematic study was missing and, therefore, I think that this is an important article.

Nanoenabled Modulation of Acidic Tumor Microenvironment Reverses Anergy of Infiltrating T Cells and Potentiates Anti-PD-1 Therapy

Zhang, Y.-X.; Zhao, Y.-Y.; Shen J.; Sun, X.; Liu, Y.; Liu, H.; Wang, Y*; Wang, J. *Nano Lett.* **2019**, *19*, 2774-2783

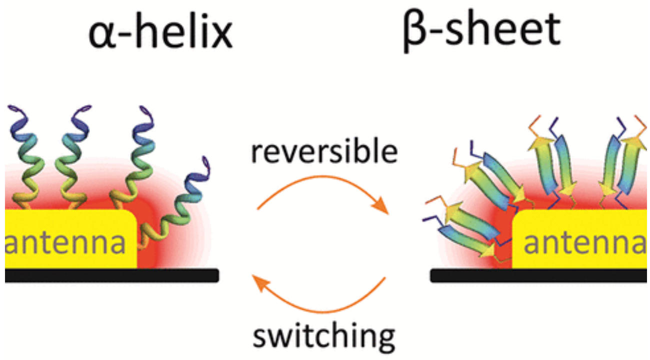


While tumor-infiltrating cytotoxic T lymphocytes play a critical role in controlling tumor development, they are generally impotent in an acidic tumor microenvironment. Systemic treatment to neutralize tumor acidity thus holds promise for the reversal of the anergic state of T cells and the improvement of T cell-associated immunotherapy. Herein, we report a proof-of-concept of RNAi nanoparticle-mediated therapeutic reversion of tumor acidity to restore the antitumor functions of T cells and potentiate the checkpoint blockade therapy. Our strategy utilized an in vivo optimized vesicular cationic lipid-assisted nanoparticle, as opposed to its micellar counterpart, to mediate systematic knockdown of lactate dehydrogenase A (LDHA) in tumor cells. The treatment resulted in the reprogramming of pyruvate metabolism, a reduction of the production of lactate, and the neutralization of the tumor pH. In immunocompetent syngeneic melanoma and breast tumor models, neutralization of tumor acidity increased infiltration with CD8+ T and NK cells, decreased the number of immunosuppressive T cells, and thus significantly inhibited the growth of tumors. Furthermore, the restoration of tumoral pH potentiated checkpoint inhibition therapy using the antibody of programmed cell death protein 1 (PD-1). However, in immunodeficient B6/Rag1−/− and NOG mice, the same treatment failed to control tumor growth, further proving that the attenuation of tumor growth by tumor acidity modulation was attributable to the activation of tumor-infiltrating immune cells.

Comment: Increased glycolysis in some cancerous cells can lead to acidic environments, which in turn can turn off the immune system's response. Here, by micellar and vesicular nanoparticles, silencing RNA for the pyruvate/lactic acid pathway is carried through the blood of the mice into tumors thereby reducing the tumor's acidity and allowing a better response. The micelles dissolve in the blood making of the vesicular delivery the mainly viable approach. However, the tumor, even if it grows slower, still grows. Between the complicated delivery and the fact that this just slows down the tumor growth it seems like there is a lot of work to be done before this technology could be used.

In Vitro Monitoring Conformational Changes of Polypeptide Monolayers Using Infrared Plasmonic Nanoantennas

Semenyshyn, R.; Hentschel, M.; Stanglmair, C.; Teutsch, T.; Tarin, C.; Pacholski, C.; Giessen, H.; Neubrech, F.* *Nano Lett.* **2019**, *19*, 1-7

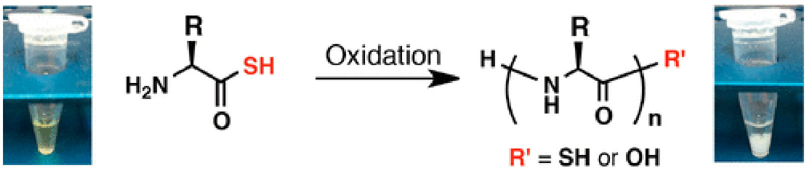


Proteins and peptides play a predominant role in biochemical reactions of living cells. In these complex environments, not only the constitution of the molecules but also their three-dimensional configuration defines their functionality. This so-called secondary structure of proteins is crucial for understanding their function in living matter. Misfolding, for example, is suspected as the cause of neurodegenerative diseases such as Alzheimer's and Parkinson's disease. Ultimately, it is necessary to study a single protein and its folding dynamics. Here, we report a first step in this direction, namely ultrasensitive detection and discrimination of in vitro polypeptide folding and unfolding processes using resonant plasmonic nanoantennas for surface-enhanced vibrational spectroscopy. We utilize poly-l-lysine as a model system which has been functionalized on the gold surface. By in vitro infrared spectroscopy of a single molecular monolayer at the amide I vibrations we directly monitor the reversible conformational changes between α-helix and β-sheet states induced by controlled external chemical stimuli. Our scheme in combination with advanced positioning of the peptides and proteins and more brilliant light sources is highly promising for ultrasensitive in vitro studies down to the single protein level.

Comment: This work manages to probe the structure of single layers of protein and monitor the transition from one structure to another. Even though this happens in a perfectly controlled media, this might be the first step towards monitoring subtle structure transitions to help explain the stability of proteins and the activity changes following environment variations.

Regioselective α-Peptide Bond Formation Through Oxidation of AminoThioacids

Okamoto, R.; Haraguchi, T.; Nomura, K.; Maki, Y.; Izumi, M.; Kajihara, Y.* *Biochemistry* **2019**, *58*, 1672-1678

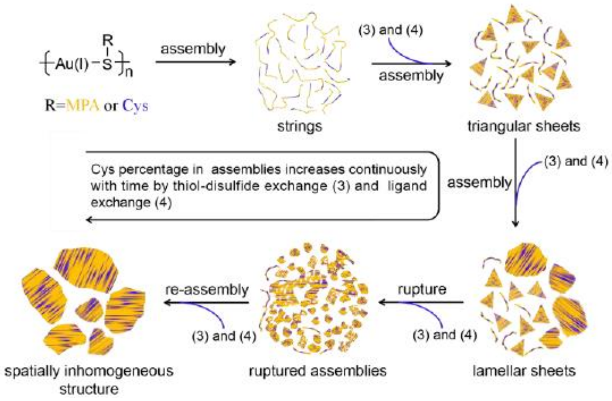


Biological systems, including ribosomes and enzymes, produce peptides with an extraordinary high speed and accuracy. On the other hand, a rational and regioselective α-peptide bond formation, without involving protecting groups, is difficult to achieve in chemical synthesis. In this study, α-amino thioacids were utilized for the generation of polypeptides without using any protecting groups. We found that an α-amino thioacid could oxidatively form a diaminoacyl-disulfide moiety and undergo a subsequent intramolecular S- to N-acyl transfer to form an α-peptide bond. Even the thioacid form of lysine, which has a free ε-amino group, generated a regioselective α-peptide bond. The oxidation of amino thioacids generated the oligomers of amino acids. Interestingly, this oligomerization reaction proceeded even in the presence of iron ore, a prebiotic element, thus suggesting a plausible prebiotic peptide bond forming reaction.

Comment: An interesting way to create a peptide bond, in the N-S acylshift vibe that makes the N-metylcystein chemistry from our group. The fact that some metal surfaces help with this oligomerization mechanism may have implications in prebiotic peptide formation. However, it leads to a multitude of sequences and is not, in its current state, relevant for precise peptide synthesis.

Reactions Coupled Self- and Co-Assembly: A Highly Dynamic Process and the Resultant Spatially Inhomogeneous Structure

Li, S.; Yu, Y.; Liu, J.; Xu, S.; Zhang, S.; Li, M.*; Zhang, S. X.; *Chem. Asian J.* **2019**, *Early View*

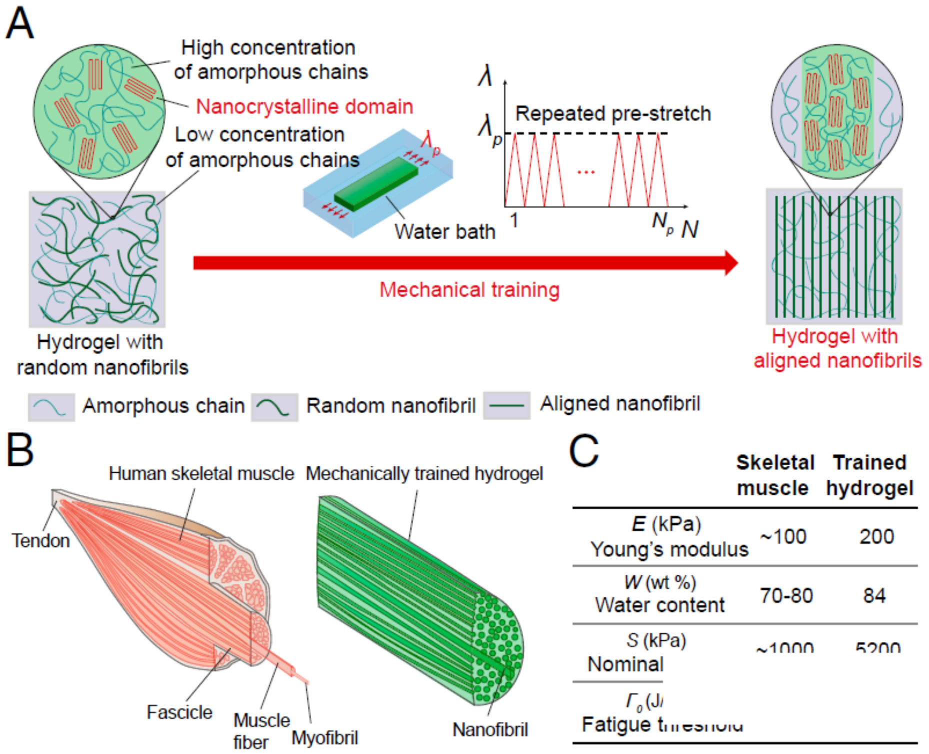


Reactions coupled self-assembly represents a step forward towards biomimetic behavior in the field of supramolecular research. Here, two pH-dependent reactions of thiol-disulfide exchange and ligand exchange were used to couple with the self-assembly of an Au(I) -thiolate coordination polymer consisting of two ligands. Thanks to the comparable rates between the reactions and self-assembly, the compositions of the assemblies change continuously with time, resulting in a highly dynamic assembly process and spatially inhomogeneous structure that are very common in life systems but cannot be easily obtained with one-pot artificial methods.

Comment: This work showing dynamical self-assembly of Au(I) -thiolate coordination polymers consisting of two ligands dependent on the time and pH. Though much of the discussion focus on the ligand exchanges, I think the detailed assembly process from string to nanosheet upon time is also very important.

Muscle-Like Fatigue-Resistant Hydrogels by Mechanical Training

Lina, S.; Liua, J.; Liua, X.; and Zhaoa, X.* *PNAS* **2019**, *116*, 21

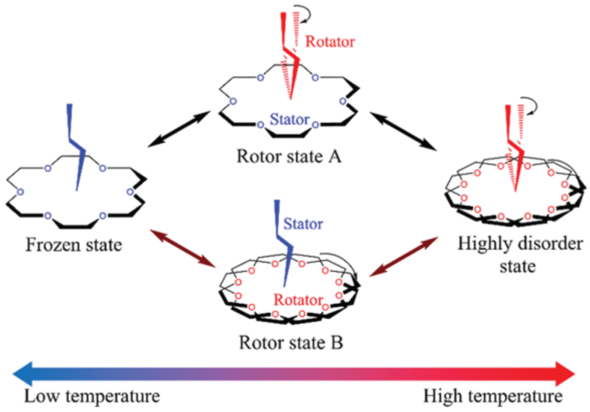


Skeletal muscles possess the combinational properties of high fatigue resistance (1,000 J/m^2), high strength (1 MPa), low Young's modulus (100 kPa), and high-water content (70 to 80 wt%), which have not been achieved in synthetic hydrogels. The muscle-like properties are highly desirable for hydrogels' nascent applications in load-bearing artificial tissues and soft devices. Here, we propose a strategy of mechanical training to achieve the aligned nanofibrillar architectures of skeletal muscles in synthetic hydrogels, resulting in the combinational muscle-like properties. These properties are obtained through the training-induced alignment of nanofibrils, without additional chemical modifications or additives. In situ confocal microscopy of the hydrogels' fracturing processes reveals that the fatigue resistance results from the crack pinning by the aligned nanofibrils, which require much higher energy to fracture than the corresponding amorphous polymer chains. This strategy is particularly applicable for 3D-printed microstructures of hydrogels, in which we can achieve isotropically fatigue-resistant, strong yet compliant properties.

Comment: An interesting example of bio-inspired composite material. The nanofibrils are synthesized by a freezing process in a PVA matrix and are then classically aligned by pre-stretching.

Unprecedented Water-Controlled Rotator–Stator Conversion of Supramolecular Rotors in Crystals

Huang, R. K.; Xiao, Z. F.; Liu, D. X.; Zhang W. X.*; and Chen X. M. *Chem. Commun.* **2019**, 55

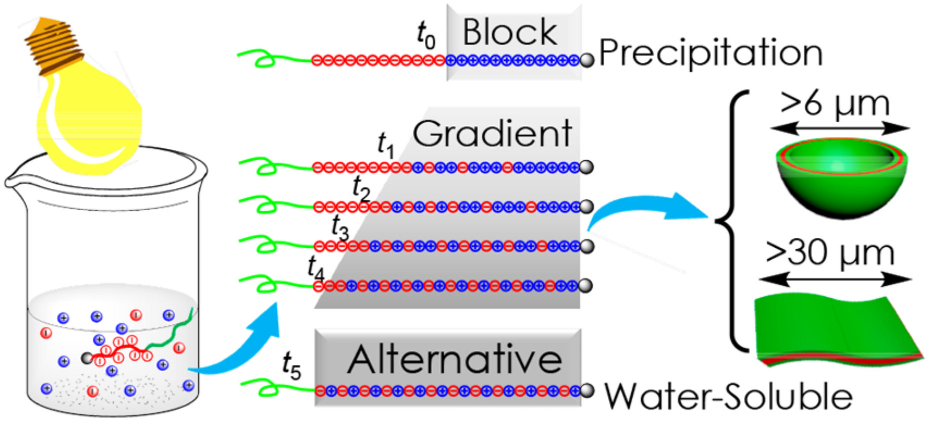


The rotational dynamics, dielectric response and phase transitions of a unique crystalline supramolecular rotor are controlled by the existence/absence of guest water molecules causing prominent effects on the supramolecular interactions. Such an unprecedented, rotationally bistable rotor can promote the understanding of precise control of molecular rotors in crystals.

Comment: As molecular motors are one of the topics of the group, this communication can be of interest. The authors propose an explanation for the interaction between water and the motors.

Sequence-Controlled Polymerization-Induced Self-Assembly

Wang, L.; Ding, Y.; Liu, Q.; Zhao, Q.; Dai, X.; Lu, X.; Cai, Y.* *ACS Macro Lett.* **2019**, 623–628.

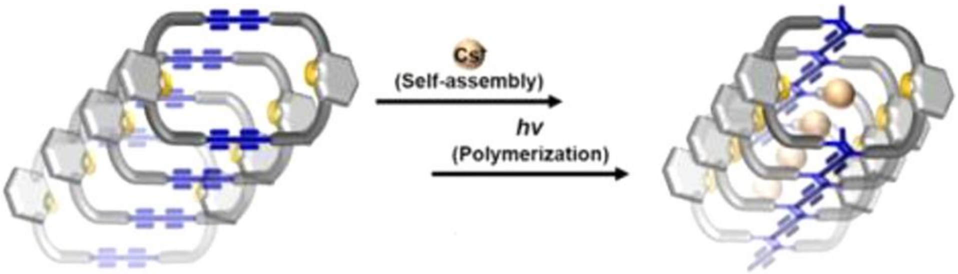


We herein present sequence-controlled polymerization-induced self-assembly (PISA) via photoswitchable reversible addition−fragmentation chain transfer (RAFT) copolymerization of oppositely-charged monomers using polyethylene glycol chain transfer-agent in water at 25 °C. Thorough block copolymerization leads to a polymerization-induced electrostatic self-assembly named ABC-mode polymerization-induced electrostatic self-assembly (PIESA), by which PEGylated (PEG, polyethylene glycol) polyion complex (PIC) spheres, lamellae, and vesicles are achieved. We demonstrate the inherent spontaneous zwitterionic alternating copolymerization nature, which leads to the charge-dictated alternating or gradient zwitterionic sequence. As such, we developed sequence-controlled synthesis of nanostructured block-gradient zwitterionic terpolymer PICs via complete zwitterionic copolymerization starting from photoswitched incomplete first polymerization, i.e., AB(BC)-mode PIESA. This sequence-controlled PISA method provides the unprecedented control of the low-dimensional polyelectrolyte complex nanostructure involving not only shape but also size and thickness of micrometer-sized ultrathin PIC vesicles and lamellae, without necessarily changing the whole chemical composition and degree of polymerization.

Comment: Here is reported the first example of sequence-controlled PISA using photo-controlled RAFT zwitterionic copolymerization of oppositely-charged monomers in water. The authors demonstrated the inherent nature of spontaneous zwitterionic alternating copolymerization, which led to the charge-dictated alternating or gradient zwitterionic sequences. They developed a sequence-controlled PISA method using photoswitchable AB(BC)-mode PIESA. This sequence-controlled PISA method provided a simple yet versatile platform for the temporal control over the block-gradient PIC nanostructure (not only shape but also size and thickness) of micrometer-sized ultrathin PIC vesicles and lamellae, under eco-friendly visible light aqueous conditions.

Cation-Directed Self-Assembly of Macrocyclic Diacetylene for Developing Chromogenic Polydiacetylene

Shin, G.; Khazi, M. I.; Kundapur, U.; Kim, B.; Kim, Y.; Lee, C. W.; Kim, J.-M. ACS Macro Lett. **2019**, *8*, 610–615.

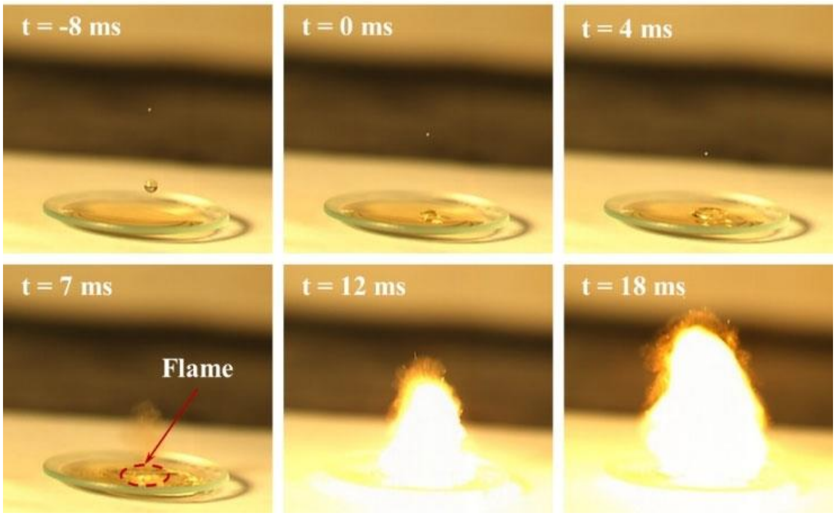


The cation-directed self-assembly process has emerged as a fascinating approach for constructing supramolecular architectures and manifested a diverse range of assembly related applications. Herein, we synthesized a macrocyclic structure containing bis-amidopyridine and photopolymerizable diacetylene template, PyMCDA. Owing to the metal coordination affinity of bis-amidopyridine and the π−π stacking characteristic of diacetylene template and complementary to the cyclic molecular framework, Cs^+-directed organic nanotubes are generated via unidirectional selfassembly of PyMCDA. The monomeric PyMCDA nanotubes are transformed into the covalently cross-linked chromogenic polydiacetylene nanotubes (PyMCPDA-Cs^+) by UV-promoted topochemical polymerization. The result of a metal−ligand coordination characteristic, geometric parameters in solid-state assemblies, and topochemical polymerization behavior reveals a generation of Cs^+ ion inserted nanotubes. Interestingly, PyMCDA-Cs^+ nanotubes display thermochromic property with a brilliant blue-to-red color transition.

Comment: A very nice article in which the authors demonstrate that the cation-directed self-assembly of PyMCDA provides a strategy for controlling the direction, geometry, and conformation of monomer units to develop polymerizable nanotubes.

Synthesis and Properties of Azide-Functionalized Ionic Liquids as Attractive Hypergolic Fuels

Wang, Z.; Pan, G.; Wang, B.; Zhang, L.; Zhao, W.; Ma, X.; Zhang*, J.; Zhang, J.* *Chem. Asian J.* **2019**, *ASAP*

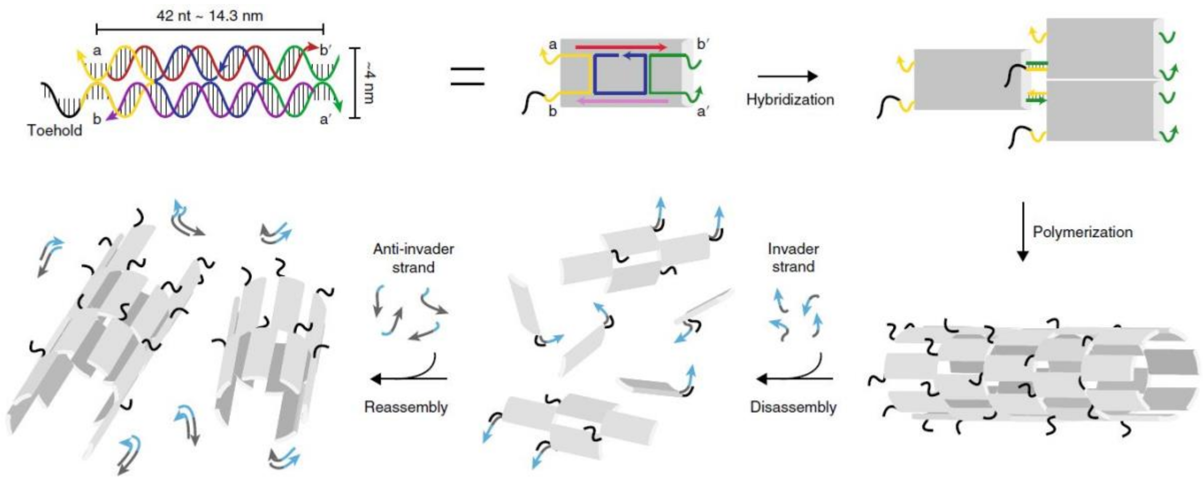


Hypergolic ionic liquids (ILs) have shown a great promise as viable replacements for toxic and volatile hydrazine derivatives used as propellant fuels, and hence, have attracted increasing interest over the last decade. To take advantage of the reactivity and high energy density of the azido group, a family of low-cost and easily prepared azide-functionalized cation-based ILs, including fuel-rich anions, such as nitrate, dicyanamide, and nitrocyanamide anions, were synthesized and characterized. All the dicyanamide- and nitrocyanamid-based ILs exhibited spontaneous combustion upon contact with 100 % HNO_3. The densities of these hypergolic ILs varied in the range 1.11–1.29 g cm^{-3}, and the density-specific impulse, predicted based on Gaussian 09 calculations, was between 289.9 and 344.9 s g cm^{-3}. The values of these two key physical properties are much higher than those of unsymmetrical dimethylhydrazine (UDMH). Among the studied compounds, compound IL-3b, that is, 1-(2-azidoethyl)-1-methylpyrrolidin-1-ium dicyanamide, shows excellent integrated properties including the lowest viscosity (30.9 M Pa s), wide liquid operating range (−70 to 205 °C), shortest ignition-delay time (7 ms) with 100 % HNO_3, and superior density specific impulse (302.5 s g cm^{-3}), suggesting promising applications with potential as bipropellant formulations. Alternative hypergolic fuels: A family of novel azide-functionalized cation-based hypergolic ionic liquids were designed and synthesized from cost-effective materials. These ionic liquids displayed excellent properties including low melting points, high thermal stability, low viscosities, and unique hypergolic reactivity, demonstrating their promise as potential alternative hypergolic fuels to toxic and volatile hydrazine derivatives.

Comment: I know only little about hypergolic ionic liquids, but ionic liquids with azido group having spontaneous combustion is an interesting thing to me. Considering that, maybe we should pay more attention when dealing with azido-functionized compounds.

Autonomous Dynamic Control of DNA Nanostructure Self-assembly

Green, L N.; Subramanian, H K. K.; Mardanlou, V.; Kim, J.; Hariadi, R F. ; Franco, E. * *Nat. Chem.* **2019**, *ASAP*

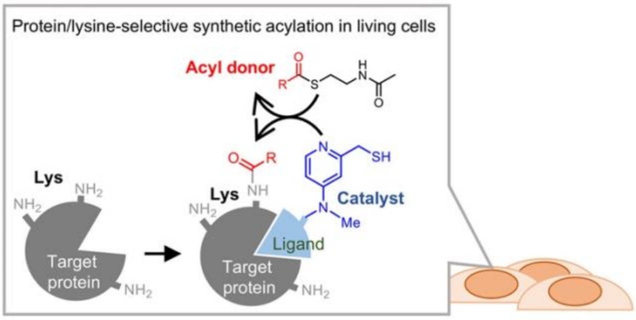


Biological cells routinely reconfigure their shape using dynamic signalling and regulatory networks that direct self-assembly processes in time and space, through molecular components that sense, process and transmit information from the environment. A similar strategy could be used to enable life-like behaviours in synthetic materials. Nucleic acid nanotechnology offers a promising route towards this goal through a variety of sensors, logic and dynamic components and self-assembling structures. Here, by harnessing both dynamic and structural DNA nanotechnology, we demonstrate dynamic control of the self-assembly of DNA nanotubes—a well-known class of programmable DNA nanostructures. Nanotube assembly and disassembly is controlled with minimal synthetic gene systems, including an autonomous molecular oscillator. We use a coarse-grained computational model to capture nanotube length distribution dynamics in response to inputs from nucleic acid circuits. We hope that these results may find use for the development of responsive nucleic acid materials, with potential applications in biomaterials science, nanofabrication and drug delivery.

Comment: The self-assembly of DNA nanostructures is not a big surprise but what is interesting is the dynamically and reversibly control reported. The correct operation of interconnected systems is also challenging. The oscillator used here is known for its sensitivity to variations enzyme concentrations and activities, yet, alternative oscillators present challenges for coupling with DNA nanostructures.

Site-Selective Synthetic Acylation of a Target Protein in Living Cells Promoted by a Chemical Catalyst/Donor System

Hamajima, A.; Fujimura, W.; Fujiwara, Y.; Yamatsugu, K.; * Kawashima, S A.;* Kana, M.*
ACS Chem. Biol. **2019**

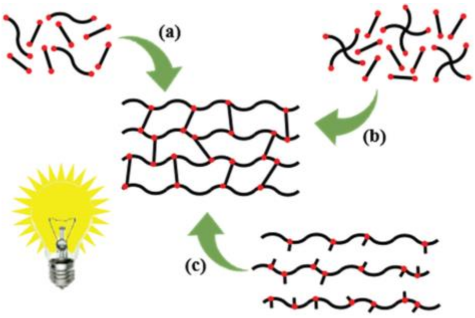


Cell biology is tightly regulated by post-translational modifications of proteins. Methods to modulate post-translational modifications in living cells without relying on enzymes or genetic manipulation are, however, largely underexplored. We previously reported that a chemical catalyst (DSH) conjugated with a nucleosome-binding ligand can activate an acyl-CoA and promote site-selective lysine acylation of histones in test tubes. In-cell acylation by this catalyst system is challenging, however, mainly due to the low cell permeability of acyl-CoA and the propensity of DSH to form inactive disulfide. Here, we report a new catalyst system effective for in-cell acylation, comprising a cell-permeable acyl donor and pro-drugged DSH. Using E. coli dihydrofolate reductase and trimethoprim as a model protein and ligand pair, the catalyst system enabled site-selective acylation of the target protein in living cells. The findings will lead to the development of useful chemical biology tools and new therapeutic strategies capable of synthetically modulating post-translational modifications.

Comment: Here they report on a chemical catalyst system that can be potentially applicable to living individuals. This is because they can modify the target lysine residues of intracellular proteins without genetic manipulation.

Chemistries and capabilities of photo-formable and photoreversible crosslinked polymer networks

Hughes,T.; Simon, G. P.; and Saito, K.; *Mater. Horiz.* **2019**. ASAP

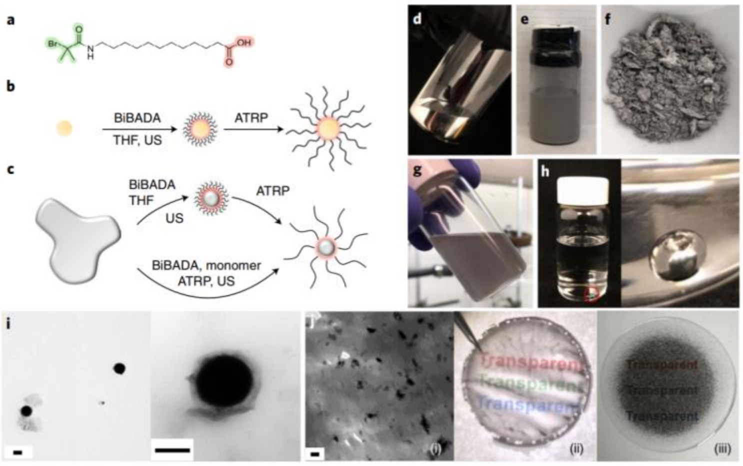


Photocuring has been found to be highly useful in a diverse range of fields, such as coatings, protein coupling, liquid crystals, photoresists, drug delivery and hydrogels. Each application and use brings new challenges, with the inventive solutions contributing to a varied catalog of chemistries. The first part of this review overviews a range of the most widely-used and inventive chemistries employed to form crosslinked networks over the last decade, as well as detailing their mechanism, limitations and benefits. The second part of this review investigates the application of photoreversibly-cured crosslinked networks as photo-healable polymers, an application that exemplifies the capabilities of photoreversible chemistry.

Comment: In this review, authors review the performance of the most utilised or innovative photochemistries used over the last decade to form crosslinked polymers. They also introduce some potential applications of using these photochemistries. Besides, several examples are also introduced.

Solution processable liquid metal nanodroplets by surface-initiated atom transfer radical polymerization

Yan, J.; Malakooti, M.; Lu, Z.; Wang, Z.; Kazem, D.; Pan,C.; Bockstaller, M.; Majidi, C.; Matyjaszewski, K.* *Nat. Nanotechnol*. **2019.** ASAP.

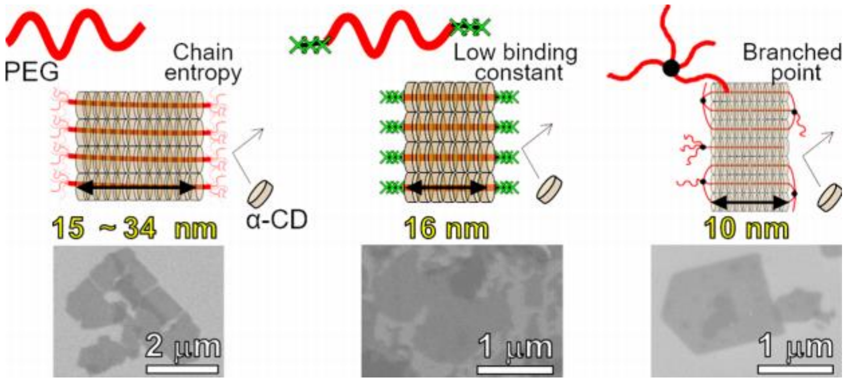


Eutectic gallium indium (EGaIn) is a liquid metal alloy at room temperature. EGaIn microdroplets can be incorporated into elastomers to fabricate highly stretchable, mechanically robust, soft multifunctional composites with high thermal stability and electrical conductivity that are suitable for applications in soft robotics and self-healing electronics. However, the current methods of preparation rely on mechanical mixing, which may lead to irregularly shaped micrometresized droplets and an anisotropic distribution of properties8. Therefore, procedures for the stabilization of sub-micrometre- sized droplets of EGaIn and compatibilization in polymer matrices and solvents have attracted significant attention. Here we report the synthesis of EGaIn nanodroplets stabilized by polymeric ligand encapsulation. We use a surface-initiated atom transfer radical polymerization initiator to covalently functionalize the oxide layer on the surface of the EGaIn nanodroplets with poly(methyl methacrylate) (PMMA), poly(n-butyl acrylate) (PBMA), poly(2-dimethylamino)ethyl methacrylate) (PDMAEMA) and poly(n-butyl acrylate-blockmethyl methacrylate) (PBA-b-PMMA). These nanodroplets are stable in organic solvents, in water or in polymer matrices up to 50 wt% concentration, enabling direct solution-casting into flexible hybrid materials. The liquid metal can be recovered from dispersion by acid treatment. The nanodroplets show good mechanical, thermal and optical properties, with a remarkable suppression of crystallization and melting temperatures (down to −80 °C from 15 °C).

Comment: From the article we learn that EGaIn droplets were first modified under ultrasonication in tetrahydrofuran by 12-(2-bromoisobutyramido)dodecanoic acid (BiBADA) followed by SI-ATRP. And in this research, the EGaIn – polymer hybrid materials via SI-ATRP enabled the synthesis of one-component polymer/EGaIn hybrid materials with well-defined microstructures possessing interesting mechanical, thermal and optical properties

Formation of Isolated Pseudo-Polyrotaxane Nanosheet Consisting of α-Cyclodextrin and Poly(ethylene glycol)

Uenuma, S.; Maeda, R.*; Yokoyama, H.; Ito, K.* *Macromolecules* **2019**, *ASAP*.

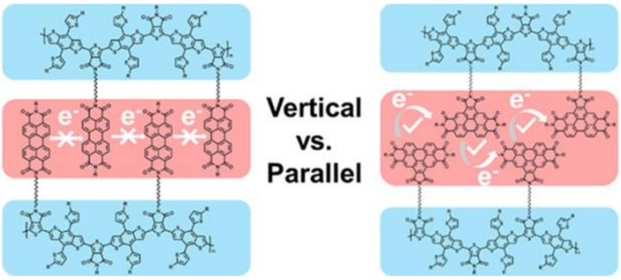


Nanosheet materials have recently attracted the attention of researchers because of their unique physical properties. In the present study, we have reported a novel methodology to fabricate isolated nanosheet materials, called pseudo-polyrotaxane (PPR) nanosheets, which are formed by biocompatible complexation between α-cyclodextrin (CD) and poly(ethylene glycol) (PEG) for the first time. When the molecular weight of axis PEG was changed in the range between 2k and 6k, isolated PPR nanosheets were obtained with thicknesses ranging from 14.6 to 33.8 nm, depending on the axis PEG length. We found that uncovering the axis ends led to the formation and isolation of PPR nanosheets when the binding constant between the axis ends and α-CD was changed. Additionally, the PPR structures consisting of multiarm PEG indicated that the uncovered parts of the axis near the branched point also promoted the formation of isolated PPR nanosheets. Uncovering the parts of the axis polymer is essential for fabricating the isolated PPR nanosheets because the uncovered parts of the axis suppress the crystal growth of α-CD in the axis direction and results in the isolation of PPR nanosheets.

Comment: Here the authors developed a novel methodology to fabricate **isolated** pseudo-polyrotaxane (PPR) nanosheets by the complexation between α-cyclodextrin (CD) and poly(ethylene glycol) (PEG). They investigated the effects of the axis polymer length, the end groups, and the use of branched axis on the structures of the resulting self-assembly.

Improving Electron Transport in a Double-Cable Conjugated Polymer via Parallel Perylenetriimide Design

Yang, F.; Li, J.; Li, C.; Li, W.* *Macromolecules* **2019**, *ASAP*.

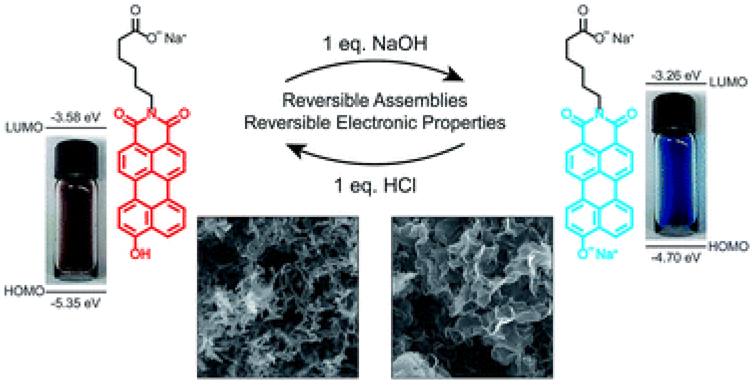


Double-cable conjugated polymer can be applied to single-component organic solar cells (SCOSCs), which have great potential to improve the stability and to simplify the fabrication procedure compared to two-component organic solar cells. However, SCOSCs always show low power-conversion efficiencies (PCEs), which is mainly due to the difficulty to tune the nanophase separation in double-cable polymers for charge transport. Herein, we are able to find a way to improve the electron transport in double-cable polymers. The idea starts by introducing a parallel and large benzo[ghi]perylenetriimide into the side chains, different from the conventional perylene bisimide (PBI) side units in double-cable polymers. The new electron-deficient side units were found to lower the crystallinity of conjugated backbone and enhance the contact region between different acceptors. This could help in electron transport in the new double-cable polymers, as confirmed by space-charge limited current measurement. Therefore, the new double-cable polymer provided a high PCE of 4.34% in SCOSCs compared to 1.92% based on the polymer with PBI side units. Our results demonstrate that by rationally designing electron-deficient side units, the electron transport in double-cable polymers can be optimized toward efficient SCOSCs.

Comment: In order to improve electron transport in single-component solar cells based on double-cable conjugated polymers, the authors used an interesting way that consist on replacing the classical perylene bisimide by a benzo[ghi]perylene triimide. This change generated a better nanophase separation between the donor and the acceptor and helped to improve the photovoltaic performance from a PCE of 1.92% to 4.34%.

Impact of Charge Switching Stimuli on Supramolecular Perylene Monoimide Assemblies

Dannenhoffer, A.; Sai, H.; Huang, D.; Nagasing, B.; Harutyunyan, B.; Fairfield, D. J.; Aytun, T.; Chin, S. M.; Bedzyk, M. J.; Olvera de la Cruz, M.; Stupp, S.* *Chem. Sci.* **2019.**



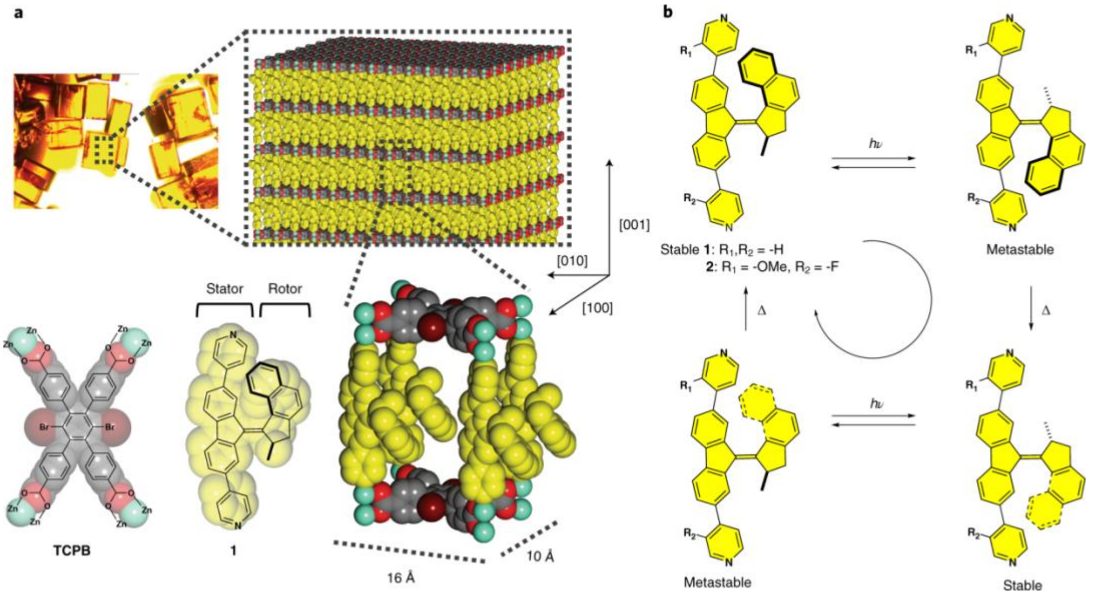
The development of stimuli-responsive amphiphilic supramolecular nanostructures is an attractive target for systems based on light-absorbing chromophores that can function as photosensitizers in water. We report here on a water soluble supramolecular carboxylated perylene monoimide system in which charge can be switched significantly by a change in pH. This was accomplished by substituting the perylene core with an ionizable hydroxyl group. In acidic environments, crystalline supramolecular nanoribbons with dimensions on the order of 500 × 50 × 2 nm form readily, while in basic solution the additional electrostatic repulsion of the ionized hydroxyl reduces assemblies to very small dimensions on the order of only several nanometers. The HOMO/LUMO levels were also found to be sensitive to pH; in acidic media the HOMO/LUMO levels are −5.65 and −3.70 eV respectively *versus* vacuum, whereas is in basic conditions they are −4.90 and −3.33 eV, respectively. Utilizing the assemblies as photosensitizers in photocatalytic production of hydrogen with

$[Mo_3S_{13}]^{2-}$ as a catalyst at a pH of 4, H_2 was generated with a turnover number of 125 after 18 hours. Charge switching the assemblies at a pH of 9–10 and using an iron porphyrin catalyst, protons could again be reduced to hydrogen and CO_2 was reduced to CO with a turnover number of 30. The system investigated offers an example of dynamic photosensitizing assemblies that can drive reactions in both acidic and basic media.

Comment: This article presents a novel water-soluble perylene monoimide amphiphile with a hydroxyl group which exhibits reversible structural, optical, and electrochemical properties in response to pH changes. Did we observe the same or similar structural evolution with the pH with our triarylamine self-assemblies?

Unidirectional Rotary Motion in a Metal–Organic Framework

Danowski, W.; van Leeuwen, T.; Abdolahzadeh, S.; Roke, D.; Browne, W. R.; Wezenberg, S. J.; Feringa, B. L.* *Nat. Nanotechnol.* **2019**, *14* (5), 488–494.



Overcrowded alkene-based light-driven molecular motors are able to perform large-amplitude repetitive unidirectional rotations. Their behaviour is well understood in solution. However, Brownian motion precludes the precise positioning at the nanoscale needed to harness cooperative action. Here, we demonstrate molecular motors organized in crystalline metal–organic frameworks (MOFs). The motor unit becomes a part of the organic linker (or strut), and its spatial arrangement is elucidated through powder and single-crystal X-ray analyses and polarized optical and Raman microscopies. We confirm that the light-driven unidirectional rotation of the motor units is retained in the MOF framework and that the motors can operate in the solid state with similar rotary speed (rate of thermal helix inversion) to that in solution. These ‘moto-MOFs’ could in the future be used to control dynamic function in crystalline materials.

Comment: In this article, Feringa and coworkers created what they call “motorized” MOF in which molecular motors are densely packed to create a macroscopic crystal. In theory, crystals like this one could be used to control the diffusion of gases, or they could function as light-powered pumps in microfluidic devises. However the study is only based on the proof of unidirectional rotations of motors. Despite the possible applications, did this article deserved to be on Nature Nanotechnology?