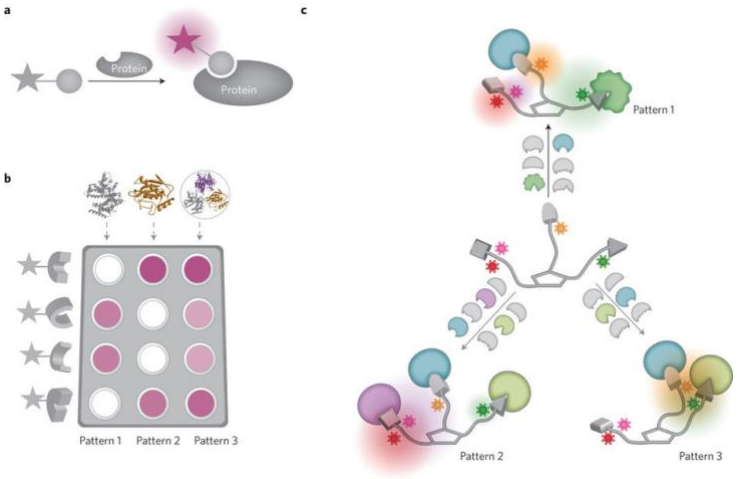
Protein Recognition by a Pattern-Generating Fluorescent Molecular Probe

Pode, Z.; Peri-Naor, R.; Georgeson, J. M.; Ilani, T.; Kiss, V.; Unger, T.; Markus, B.; Barr, H. M.; Motiei, L; Margulies, D.* *Nat. Nanotechnol.* **2017**, *12*, 1161.

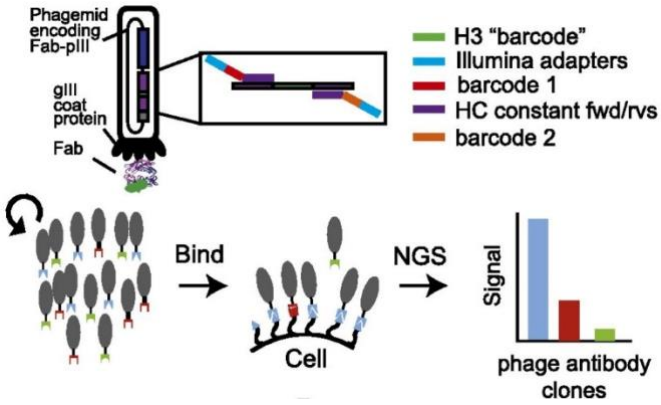


Fluorescent molecular probes have become valuable tools in protein research; however, the current methods for using these probes are less suitable for analysing specific populations of proteins in their native environment. In this study, we address this gap by developing **a unimolecular fluorescent probe** that combines the properties of small-molecule-based probes and cross-reactive sensor arrays (the so-called chemical 'noses/tongues'). On the one hand, the probe can detect different proteins by generating **unique identification (ID) patterns**, akin to cross-reactive arrays. On the other hand, **its unimolecular scaffold and selective binding** enable this ID-generating probe to identify combinations of specific protein families within complex mixtures and to discriminate among isoforms in living cells, where macroscopic arrays cannot access. The **ability to recycle the molecular device** and use it to track several binding interactions simultaneously further demonstrates how this approach could expand the fluorescent toolbox currently used to detect and image proteins.

Comment: This is my first contribution for this week featuring a proteomic assay. Margulies *et al* use a unimolecular ID-generating probe to detect and image specific protein families. This unimolecular probe contains three protein binders and four partially spectrally overlapping fluorescent dyes. Three binders specific for three different protein families. Four dyes to produce unique fluorescence fingerprints. Apart from this, the ID-probe can be recycled for future use.

Highly Multiplexed and Quantitative Cell-Surface Protein Profiling Using Genetically Barcoded Antibodies

Pollock, S. B.; Hu, A.; Mou, Y.; Martinko, A. J.; Julien, O.; Hornsby, M.; Ploder, L.; Adams, J. J.; Geng, G.; Müschen, M.; Sidhu, S. S.; Moffat, J.; Wells, J. A.* *Proc. Natl. Acad. Sci. U.S.A.* **2018**, *115*, 2836.

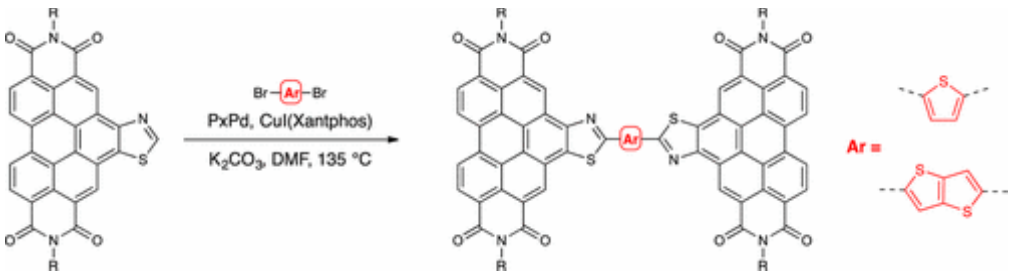


Human cells express thousands of different surface proteins that can be used for cell classification, or to distinguish healthy and disease conditions. A method capable of profiling a substantial fraction of the surface proteome simultaneously and inexpensively would enable more accurate and complete classification of cell states. We present a highly multiplexed and quantitative surface proteomic method using genetically barcoded antibodies called **phage-antibody next-generation sequencing (PhaNGS)**. Using 144 preselected antibodies displayed on filamentous phage (Fab-phage) against 44 receptor targets, we assess changes in B cell surface proteins after the development of drug resistance in a patient with acute lymphoblastic leukemia (ALL) and in adaptation to oncogene expression in a Myc-inducible Burkitt lymphoma model. We further show PhaNGS can be applied at the single-cell level. Our results reveal that a common set of proteins including FLT3, NCR3LG1, and ROR1 dominate the response to similar oncogenic perturbations in B cells. Linking high-affinity, selective, genetically encoded binders to NGS enables direct and highly multiplexed protein detection, **comparable to RNA-sequencing for mRNA.** PhaNGS has the potential to profile a substantial fraction of the surface proteome simultaneously and inexpensively to enable more accurate and complete classification of cell states.

Comment: Next-generation sequencing (NGS) has allowed the comprehensive study of the genome and transcriptome. However, a similarly broad, highly multiplexed, and inexpensive method for proteomics using NGS remains elusive. Here, they describe a phage display-based method using preselected antibodies that are genetically encoded and capable of **simultaneous profiling of hundreds of cell-surface targets on cells** in culture or singly **at low cost** and **without the need for chemical conjugation to purified antibodies.** They use the method to identify cell-surface proteins that change in cancer cells, some of which are coordinately regulated and could lead to new biomarkers and cancer targets.

Synthesis and C–H Functionalization Chemistry of Thiazole-Semicoronenediimides (TsCDIs) and -Coronenediimides (TCDIs)

Shi, Q.; Andreansky, E. S.; Marder, S. R.; Blakey, S. B.* *J. Org. Chem.* **2017**, *82*, 10139.

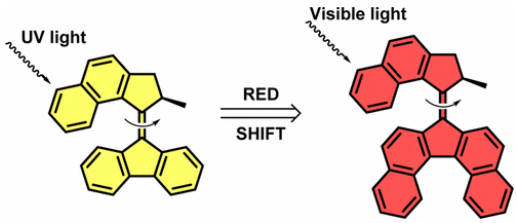


Coronenediimide (CDI) derivatives have a planar structure, a reasonably **high electron affinity**, and a rigid and extended delocalized π-system. Therefore, this core and variants thereof may be promising building blocks for the synthesis of **electron transport materials**. Herein, we have synthesized thiazole-semicoronenediimides (TsCDIs) and -coronenediimides (TCDIs) by a two-step process from a perylenediimide (PDI) precursor. Conditions for C–H arylation and heteroarylation of the thiazole moiety of this core were developed and were successfully used for the synthesis of dimer, triad, and **polymeric** materials. The **optical** and **electrochemical properties** of these materials and their monomers were examined as a function of side-chain modification and π-extension. With their broad optical absorption and low reduction potentials, these materials could be candidates as **organic semiconductors** for applications in OFETs and as nonfullerene acceptors.

Comment: Organic synthesis is taking material science to another level! This publication presents a new organic semiconductor material with special properties.

Visible-Light Excitation of a Molecular Motor with an Extended Aromatic Core

Van Leeuwen, T.; Pol, J.; Roke, D.; Wezenberg, S. J.; Feringa, B., L.* *Org. Lett.* 2017, *19, 1402-1405*.

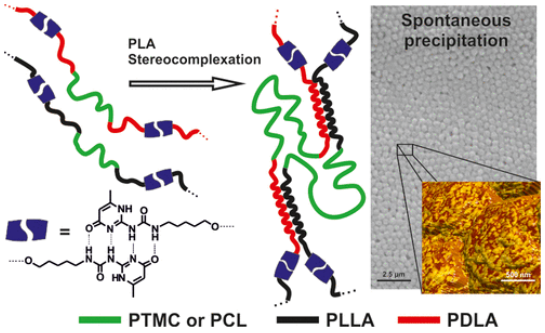


Exploring routes to visible-light-driven rotary motors, the possibility of red-shifting the excitation wavelength of molecular motors by extension of the aromatic core is studied. Introducing a dibenzofluorenyl moiety in a standard molecular motor resulted in red-shifting of the absorption spectrum. UV/vis and ^{1}H NMR spectroscopy showed that these motors could be isomerized with light of wavelengths up to 490 nm and that the structural modification did not impair the anticipated rotary behavior. Extension of the aromatic core is therefore a suitable strategy to apply in pursuit of visible-light-driven molecular motors.

Comment: The general idea of this paper is to manage a red shift of the molecular motor activation into visible light for the purpose of apply it into biological systems (Indeed, the activation of the commons molecular motors is done in the UV range). To do that, Feringa and al designed a novel molecular structure by increasing aromatic delocalization. To probe the shift, DFT calculations and UV-vis spectroscopy was used.

Self-assembly of Triblock Copolymers from Cyclic Esters as a Tool for Tuning their Particles Morphology

Socka, M.*; Brzezièski, M.; Michalski, A.; Kacprzak, A.; Makowski, T.; Andrzej, D
Langmuir, ASAP.

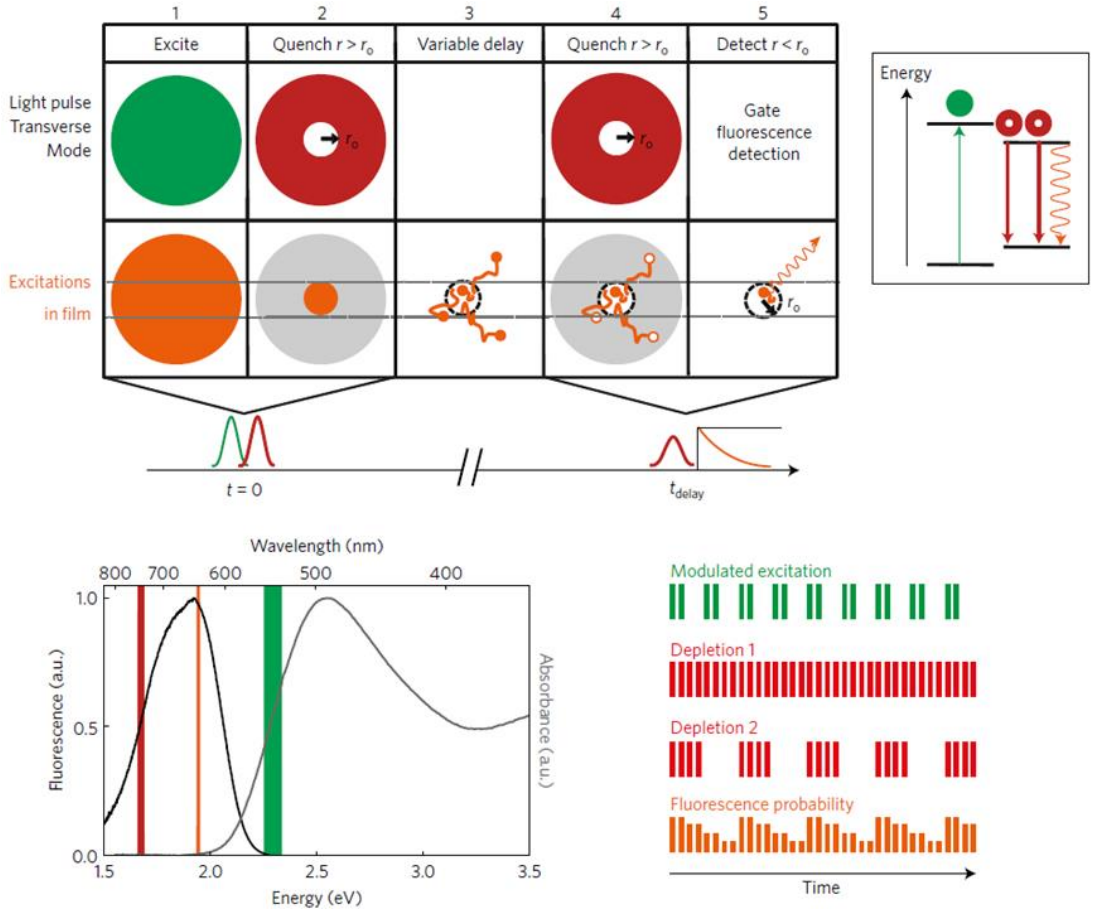


This paper presents the effect of end groups, chain structure, and stereocomplexation on the microparticle and nanoparticle morphology and thermal properties of the supramolecular triblock copolyesters. Therefore, the series of the triblock copolymers composed of L,L-and D,D-lactide, trimethylene carbonate (TMC), and ε-caprolactone (CL) with isopropyl (*i*Pr) or 2-ureido-4-[1*H*]-pyrimidinone (UPy) end groups at both chain ends were synthesized. In addition, these copolymers were intermoleculary stereocomplexed by polylactide (PLA) blocks with an opposite configuration of repeating units to promote their self-assembly in various organic solvents. The combination of two noncovalent interactions of the end groups and PLA enantiomeric chains leads to stronger interactions between macromolecules and allows for alteration of their segmental mobility. The simple tuning of the copolymer microstructure and functionality induced the self-assembly of macromolecules at liquid/liquid interfaces, which consequently leads to their phase separation in the form of particles with diameters ranging from 0.1 μm to 10 μm. This control is essential for their potential applications in the biomedical field, where biocompatible and well-defined microparticles and nanoparticles are highly desirable.

Comment: Interesting paper about the physicochemical behavior of the self-assembled tri-block polymer with UPy end units. Some of the results could be useful to compare with the bulk double dynamic material and also can be an interesting resource for the double dynamic project.

Resolving Ultrafast Exciton Migration in Organic Solids at the Nanoscale

Penwell, S. B.; Ginsberg, L. D. S.; Noriega, R. and Ginsberg, N. S.* *Nat. Mat.* **2017**, *16*, 1136–1142

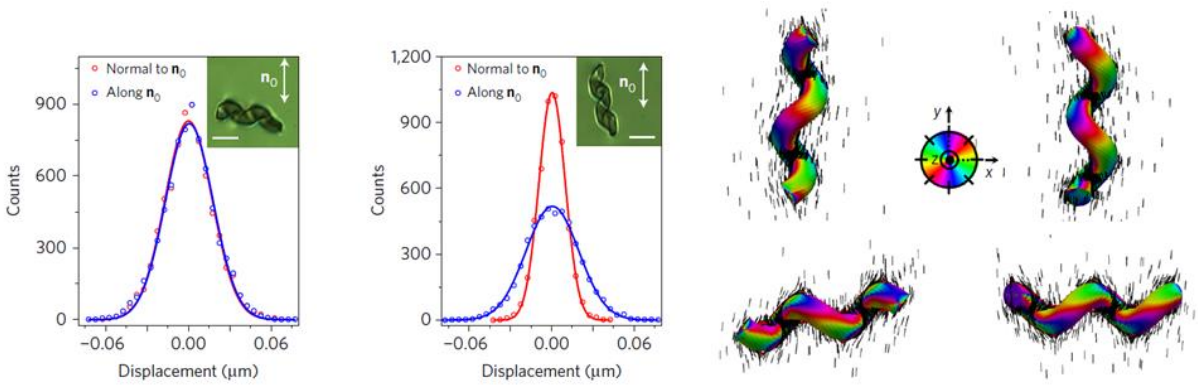


Effectiveness of molecular-based light harvesting relies on transport of excitons to charge-transfer sites. Measuring exciton migration, however, has been challenging because of the mismatch between nanoscale migration lengths and the diffraction limit. Instead of using bulk substrate quenching methods, here we define quenching boundaries all-optically with sub-diffraction resolution, thus characterizing spatiotemporal exciton migration on its native nanometre and picosecond scales. By transforming stimulated emission depletion microscopy into a time-resolved ultrafast approach, we measure a 16-nm migration length in poly(2,5-di(hexyloxy)cyanoterephthalylidene) conjugated polymer films. Combined with Monte Carlo exciton hopping simulations, we show that migration in these films is essentially diffusive because intrinsic chromophore energetic disorder is comparable to chromophore inhomogeneous broadening. Our approach will enable previously unattainable correlation of local material structure to exciton migration character, applicable not only to photovoltaic or display-destined organic semiconductors but also to explaining the quintessential exciton migration exhibited in photosynthesis.

Comment: A new state of the art approach to break the diffraction limit and to visualize exciton migration. Although interesting, it seems a complicated and specific method and therefore limited.

Chiral Liquid Crystal Colloids

Yuan, Y.; Martinez, A.; Senyuk, B.; Tasinkevych, M. and Smalyukh, I. I.* *Nat. Mat.* **2018**, *17*, 71–80

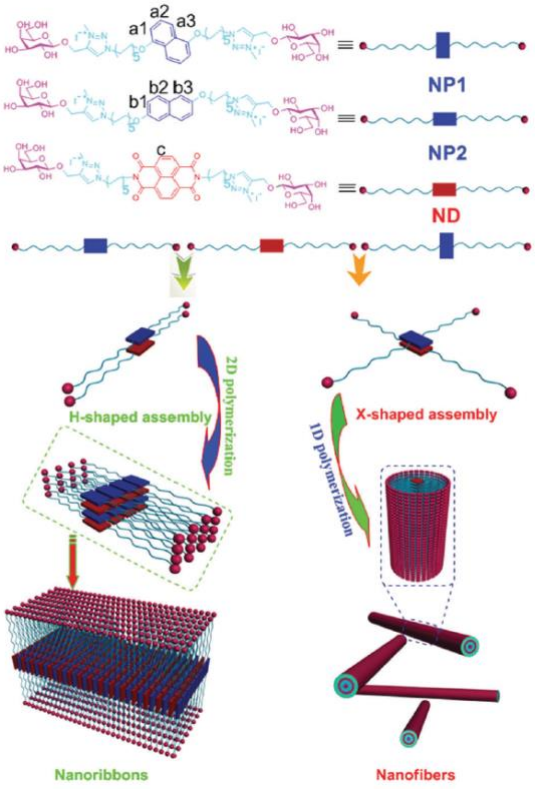


Colloidal particles disturb the alignment of rod-like molecules of liquid crystals, giving rise to long-range interactions that minimize the free energy of distorted regions. Particle shape and topology are known to guide this self-assembly process. However, how chirality of colloidal inclusions affects these long-range interactions is unclear. Here we study the effects of distortions caused by chiral springs and helices on the colloidal self-organization in a nematic liquid crystal using laser tweezers, particle tracking and optical imaging. We show that chirality of colloidal particles interacts with the nematic elasticity to predefine chiral or racemic colloidal superstructures in nematic colloids. These findings are consistent with numerical modelling based on the minimization of Landau–de Gennes free energy. Our study uncovers the role of chirality in defining the mesoscopic order of liquid crystal colloids, suggesting that this feature may be a potential tool to modulate the global orientated self-organization of these systems.

Comment: Not only they describe how chirality affects the self-assembly (SA) process, they also explain why the system behaves in that manner. This allows predicting SA processes, which is an important tool for the design of SA systems with pre-determined properties.

Supramolecular Self-assemblies for Bacterial Cell Agglutination Driven by Directional Charge-transfer interactions

Wu, D.*; Shen, J.; Bai, H.; Yu, G. *Chem. Commun.* **2018**, *53*, 2922.

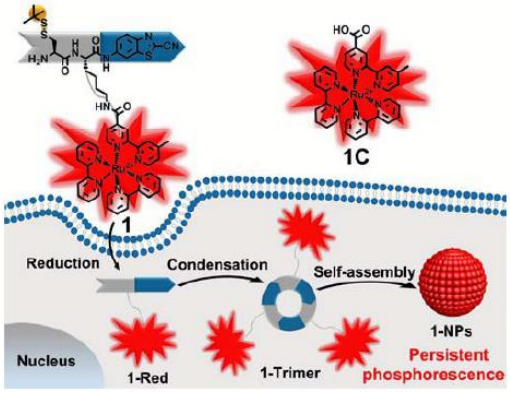


Two supramolecular amphiphiles are fabricated through directional charge-transfer interactions, which self-assemble into nanofibers and nanoribbons. Due to the existence of galactose on their surface, these self-assemblies act as a cell glue to agglutinate *E. coli*, benefiting from multivalent interactions.

Comment: The authors designed and synthesized two electron-rich amphiphiles and one electron-deficient amphiphile. They can form two self-assemblies (nanofibers and nanoribbons) due to the different lateral substitutional positions at the naphthalene core. We could consider the positional effect of chain substitution in our molecular designs. For instance, we could envision to find some self-assemblies' applications in biochemistry by modifying special recognition points.

Intracellular Self-assembly of $Ru(bpy)_3^{2+}$ Nanoparticles Enables Persistent Phosphorescence Imaging of Tumor

Li, J.; Hai, Z.; Xiao, H.; Yi, X.*; Liang, G.* *Chem. Commun.* **2018**. Doi: 10.1039/C8CC01759J.

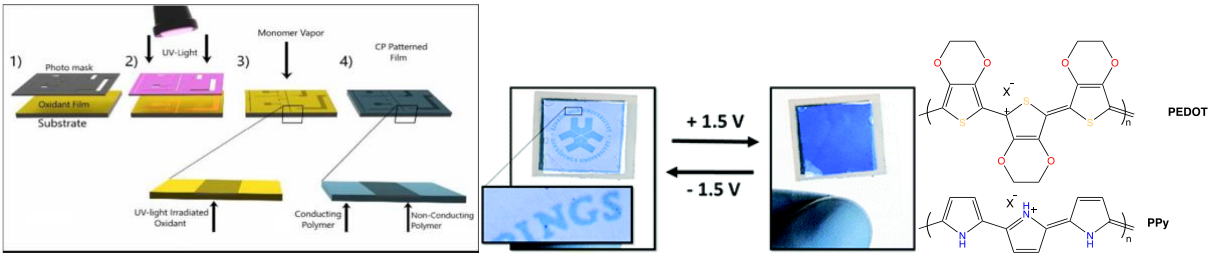


Nanoprobes are advantageous over small molecular probes in sensitivity but most luminescence molecules used to construct the nanoprobes often suffer from an aggregation-caused quenching effect. Herein, we rationally designed a small molecular probe Cys(StBu)-Lys(Ru(bpy)$_3^{2+}$)-CBT (1) which "smartly" self-assembled into nanoparticles 1-NPs inside cells with non-quenched, persistent phosphorescence. Employing this property, we successfully applied 1 for long time sensing biothiol activity inliving HepG2 cells and tumors. We envision that, by modifying the amino group with an enzyme substrate, our probe 1 could be further developed for sensing intracellular enzyme activity with non-quenched, persistent phosphorescence.

Comment: A nanoparticle probe is designed and applied to phosphorescence imaging of tumors. The click condensation between 2-cyanobenzothiazole and cysteine is quite interesting and is triggered by an intracellular reducing environment.

Controlling the Electrochromic Properties of Conductive Polymers Using UV-Light

Brooke, R.; Edberg, J.; Iandolo, D.; Berggren, M.; Crispin, C.; Engquist, I.* *J. Mater. Chem. C.* **2018**, Advance Article.

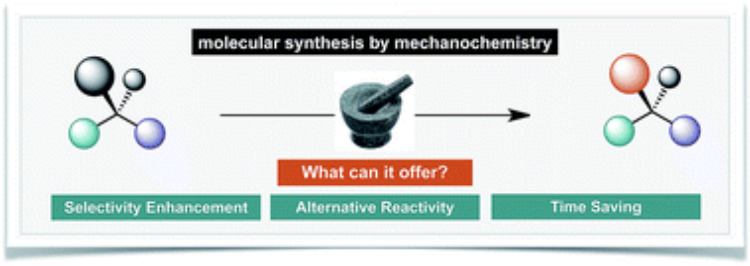


The phenomenon of electrochromism in conductive polymers is well known and has been exploited in many scientific reports. Using a newly developed patterning technique for conductive polymers, we manufactured **high-resolution electrochromic devices from the complementary polymers PEDOT and polypyrrole**. The technique, which combines **UV-light exposure with vapor phase polymerization**, has previously only been demonstrated with the conductive polymer PEDOT. We further demonstrated how the same technique can be used to control the optical properties and the electrochromic contrast in these polymers. Oxidant exposure to UV-light prior to vapor phase polymerization showed a reduction in polymer electrochromic contrast allowing high-resolution (100 µm) patterns to completely 'disappear' while applying a voltage bias due to their optical similarity in one redox state and dissimilarity in the other. This unique electrochromic property enabled us to construct devices displaying images that appear and disappear with the change in applied voltage. Finally, a modification of the electrochromic device architecture permitted a dual image electrochromic device incorporating patterned PEDOT and patterned polypyrrole on the same electrode, allowing the switching between two different images.

Comment: Even though the applications and the general concept may not interest you, some techniques might. Indeed, the authors used vapour phase polymerization triggered by the presence of an oxidative agent (Fe(Tos)$_3$) to form thin film of conductive polymer (<300 nm) and to control the physical properties of the surface. Moreover, the characterization techniques of the conductivity, the thickness, the morphology and of the colour contrast of the obtained polymer may be useful.

Mechanochemistry as an Emerging Tool for Molecular Synthesis: What Can It Offer?

Howard, J. L.; Cao, Q.; Browne, D. L.* *Chem. Sci.* **2018**, Advance Article.

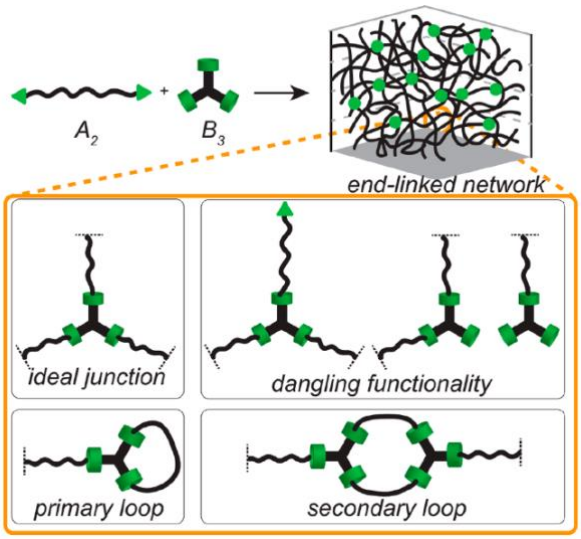


Mechanochemistry is becoming more widespread as a technique for molecular synthesis with new mechanochemical reactions being discovered at increasing frequency. Whilst mechanochemical methods are **solvent free** and can therefore lead to improved sustainability metrics, it is more likely that the significant differences between reaction outcomes, reaction selectivities and reduced reaction times will make it a technique of interest to synthetic chemists. Herein, we provide an overview of mechanochemistry reaction examples, with 'direct' comparators to solvent based reactions, which collectively seemingly show that solid state grinding can lead to **reduced reaction times, different reaction outcomes in product selectivity** and in some instances **different reaction products**, including products not accessible in solution.

Comment: Are you tired of being unable to solubilize your reagents? You would like to save the planet by avoiding the use some nasty solvents? Then mechanochemistry is made for you! More seriously, this review allows you to understand the different benefits that mechanochemistry can offer (solvent free, lower time of reaction, increase of product selectivity or new reaction products). It seems that it is still a quite unexplored field in chemistry but this comprehensive paper explains clearly the basics and our current understanding of the phenomena.

Counting Secondary Loops Is Required for Accurate Prediction of End-Linked Polymer Network Elasticity

Wang, J.; Lin, T.-S.; Gu, Y.; Wang, R.; Olsen, B. D.*; Johnson, J. A.* *ACS Macro Lett.* **2018**, *7*, 244–249.

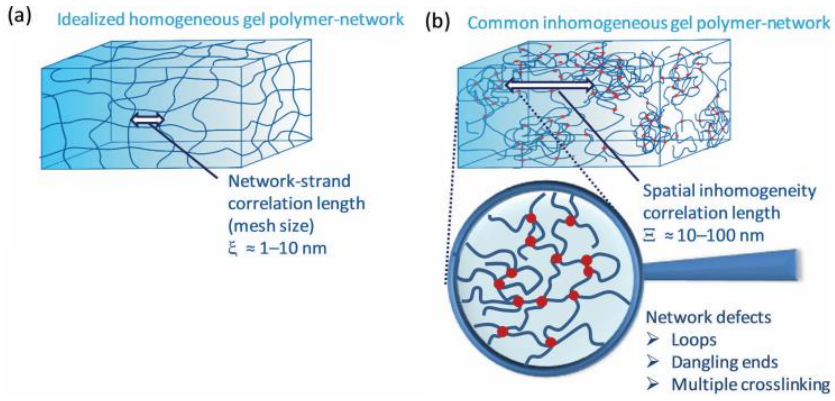


To predict and understand the properties of polymer networks, it is necessary to quantify network defects. Of the various possible network defects, loops are perhaps the most pervasive and yet difficult to directly measure. **Network disassembly spectrometry (NDS)** has previously enabled counting of the simplest loops—primary loops—but higher-order loops, e.g., secondary loops, have remained elusive. Here, we report that the introduction of a nondegradable tracer within the NDS framework enables the simultaneous measurement of primary and secondary loops in end-linked polymer networks for the first time. With this new "NDS2.0" method, the concentration dependences of **the primary and secondary loop fractions are measured**; the results agree well with a purely topological theory for network formation from phantom chains. In addition, semibatch monomer addition is shown to decrease both primary and secondary loops, though the latter to a much smaller extent. Finally, using the measured primary and secondary loop fractions, we were able to predict the shear storage modulus of end-linked polymer gels via **real elastic network theory (RENT)**.

Comment: Networks inherently contain defects (*vide supra*) that, first, impair the mechanical properties of the material, but also impair a correct prediction with simple theoretical models. Here, the authors report a method to quantify the loops in a network, **specifically secondary loops**, and they correlate their results with the theory they developed. It may be an interesting technique for the photo-responsive gels, since they also use a PEG-based network.

Dynamics-Based Assessment of Nanoscopic Polymer-Network Mesh Structures and Their Defects

Saalwächter, K.; Seiffert, S.* *Soft Matter* **2018**, *14*, 1976–1991.



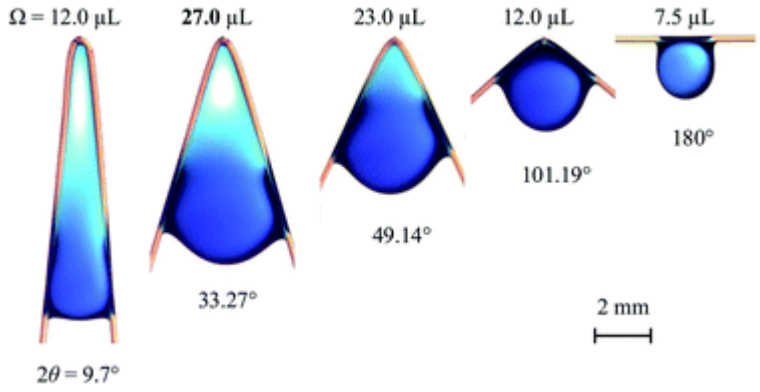
Polymer-network gels often exhibit complex nanoscopic architectures. First, the polymer-network mesh topology on scales of 1–10 nm is usually not uniform and regular, but disordered and irregular. Second, on top of that, many swollen polymer networks display spatial inhomogeneity of their polymer segmental density and crosslinking density on scales of 10–100 nm. This multi-scale structural complexity affects the permeability, mechanical strength, and optical clarity of the polymer gels, which is of central relevance for their performance in popular applications. As a result, there is a need to characterize the polymer network structures on multiple scales. On the scale of the spatial inhomogeneity of crosslinking, 10–100 nm, scattering of neutrons, X-rays, and light has extraordinary utility and is well established. **On the scale of the mesh topology, 1–10 nm, in contrast, experimental techniques are less established**. This review intends to close this gap by reviewing two intrinsically dynamic methods that yield information on polymer network mesh structures. First, **NMR-based assessment** of residual dipolar proton-spin couplings, which arise upon the introduction of crosslinks into a liquidlike polymer system to impart partial solidlike characteristics, is suitable to quantitatively assess network

meshes and local network defects. Second, **diffusive penetration of molecular, macromolecular, and mesoscopic colloidal probes** through a polymer gel provides insight into its obstructing network mesh structure and its potential irregularity. Either method is highly synergistic to scattering-based assessment of the network structures on larger scales, and in concert, a rich picture on the nano- and mesoscopic gel topology is obtained.

Comment: On the same topic as the previous article, that is, characterization of defects in networks, the authors here discuss the methods used for the determination of the topology at the **mesh scale** in a **non-destructive way**. It might also be interesting for those working on gels.

Drop on a Bent Fibre

Pan, Z.*; Weyer, F.; Pitt, W. G.; Vandewalle, N.; Truscott, T. T.* *Soft Matter* **2018**. Advance Article.

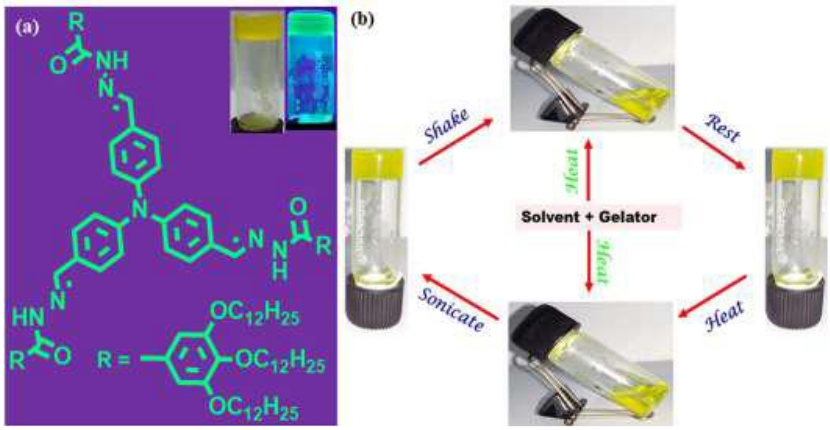


Inspired by the huge droplets attached on cypress tree leaf tips after rain, we find that **a bent fibre can hold significantly more water in the corner than a horizontally placed fibre** (typically up to three times or more). The maximum volume of the liquid that can be trapped is remarkably affected by the bending angle of the fibre and surface tension of the liquid. We experimentally find the optimal included angle (~ 36°) that holds the most water. Analytical and semi-empirical models are developed to explain these counter-intuitive experimental observations and predict the optimal angle. The data and models could be useful for designing microfluidic and fog harvesting devices.

Comment: Although this work has little to do with the topics studied by our team, the authors propose a nice introductory story with their inspiration by nature, and they did a remarkable job to develop a model for their experimental results. It is also quite interesting to observe that **the optimal included angle is independent of the surface tension of the liquid.**

Triarylamine -Cored- Dendritic Molecular Gel for an Efficient Colorometric, Fluorometric and Impedometeric Detection of Picric Acid

Mondal, S; Bairi, P; Das, S; Nandi, A. K.* *Chem. Eur. J.* 2018, ASAP.



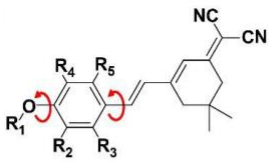
Detection of nitroaromatics at ultralow level is a major security concern in defense, forensic, and environmental issues. In this endeavor, a new triarylamine-cored-dendritic gelator(**OGR**) is synthesized producing thermoreversible, thixotropic and fluorescent gel in n-octanol. On gelation both π-π* transitions and emission peak of gelator show red shift with a 4.5-fold increase of fluorescence intensity in gel state indicating J-aggregation. The lone pair electrons of nitrogen in **OGR** moiety makes it a donor and electron transfer occurs to acceptor nitroaromatics causing fluorescence quenching which is further promoted due to its acidity. Stern−Volmer rate constant measured for different nitroaromatics exhibit it senses picric acid (PA) best. The contact mode technique using paper strips of **OGR** can detect PA in naked eye under UV light till 10^{-11} M concentration within 30 sec. Reusability of the gel is achieved by treating **OGR@PAx** with NaOH solution. Impedance spectral results indicate a decrease of both charge-transport resistance and Wraburg impedance on successive addition of PA. The limit of detection of PA measured from fluorescent and impedance measurement matches well. Thus **OGR** gel is a reusable, low-cost specific sensor for PA, in naked eye, fluorescence and impedance techniques.

Comment: An interesting application of a triarylamine-based gel as sensor.

Molecular Viscosity Sensors with Two Rotators for Optimizing the Fluorescence Intensity-Contrast Trade-off

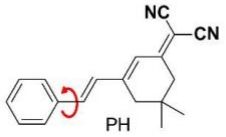
Lee, S. C.; Lee, C. L.*; Heo, J.; Jeong, C. U.; Lee,G. H.; Kim, S.*; Yoon, W.; Yun,H. Park, S. O.; Kwak, S. K.; Park, S. H.; Kwon, S. P.* *Chem. Eur. J.* **2018**, *24*, 2888.

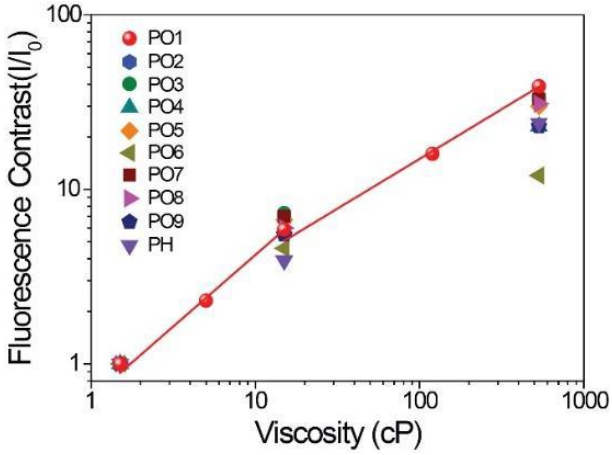
(a)



R_1	R_2	R_3	R_4	R_5	Abbr.
CH_3	H	H	H	H	PO1
CH_3	CH_3	H	H	H	PO2
CH_3	CH_3	CH_3	H	H	PO3
CH_3	OCH_3	H	H	H	PO4
CH_3	H	OCH_3	H	H	PO5
CH_3	OCH_3	H	OCH_3	H	PO6
CH_3	H	OCH_3	H	OCH_3	PO7
	H	H	H	H	PO8
	H	H	H	H	PO9

(b)





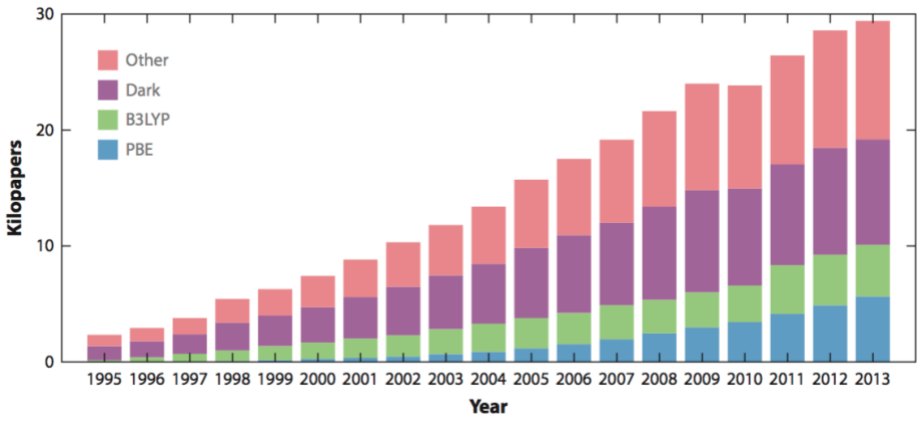
We report on a series of fluorescent molecular rotors by introducing two rotational groups ("rotators"), which exhibit different rotational and electron-donating abilities. While the controlled molecular rotor, PH, includes a single rotator (the widely used phenyl group), the PO molecular rotors consist of two rotators, a phenyl group and an alkoxy group, which exhibits simultaneous strong electron-donating and easy rotational abilities. Compared to the controlled rotor PH, PO molecular rotors exhibited one order of magnitude higher quantum yield (fluorescence intensity) and simultaneously exhibited significantly higher fluorescence contrast.

These properties are directly related to the strong electron-donating ability and low energy barrier of rotation of the alkoxy group, which were confirmed by dynamic fluorescence experiments and quantum chemical calculations. The PO molecular rotors exhibited two fluorescence relaxation pathways, while the PH molecular rotor exhibited a single fluorescence relaxation pathway. Cellular fluorescence imaging with PO molecular rotors for mapping cellular viscosity was successfully demonstrated.

Comment: A nice way to tune the fluorescence changing the viscosity of the system.

DFT: A Theory Full of Holes?

Pribram-Jones, A.*; Gross, D. A.; Burke, K. *Annu. Rev. Phys. Chem.* **2015**, *66*, 283.

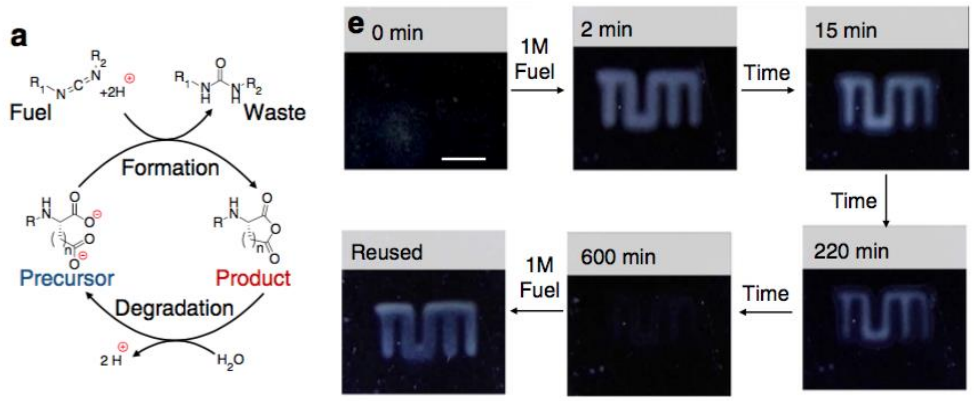


This article is a rough, quirky overview of both the history and present state of the art of density functional theory. The field is so huge that no attempt to be comprehensive is made. We focus on the underlying exact theory, the origin of approximations, and the tension between empirical and nonempirical approaches. Many ideas are illustrated on the exchange energy and hole. Features unique to this article include how approximations can be systematically derived in a nonempirical fashion and a survey of warm dense matter.

Comment: It slowly becomes clear that in a near future everything needs to be "computer assisted", and that obviously also includes chemistry. Our path towards computational chemistry started very long time ago and nowadays it is common practice to have calculations of molecular, and electronic, structure on a good part of the published literature. Yet, the universe of people/scientist performing calculations is vast and ranges from those who should never (even) have approached a computer to those who know too well what they are doing but have forgotten reality. It might be important to have at least some idea on the matter, and what best option than a review that is light to read? It is **almost fun and with some historical context**. To go a bit further into the matter, there are lots of papers not aimed to have you running your own calculations but to provide an understand of the limitations and tendencies. For instance *Science* **2017**, *355*, 49, a Science paper that got agued on and about.

Non-equilibrium Dissipative Supramolecular Materials with a Tunable Lifetime

Tena-Solsona, M.; Rieß, B.; Grötsch, R. K.; Löhrer, F. C.; Wanzke, C.; Käsdorf, B.; Bausch, A. R.; Müller-Buschbaum, P.; Lieleg, O.; Boekhoven, J.* *Nat. Commun.* **2017**, *8*, 15895.

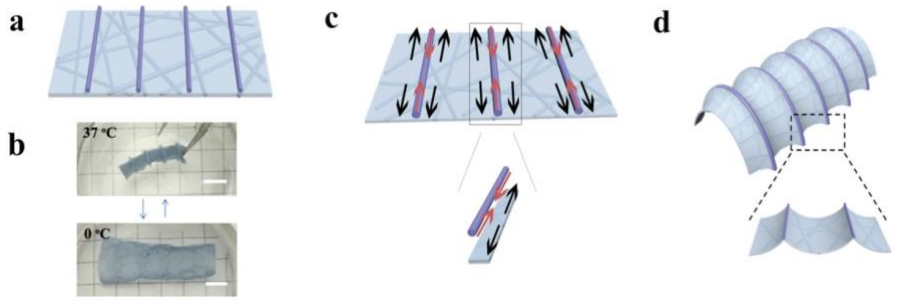


Many **biological materials** exist in **non-equilibrium** states driven by the irreversible consumption of high-energy molecules like ATP or GTP. These energy-dissipating structures are governed by kinetics and are thus endowed with unique properties including spatio-temporal control over their presence. Here we show **man-made equivalents of materials driven by the consumption of high-energy molecules** and explore their unique properties. A chemical reaction network converts dicarboxylates into metastable anhydrides driven by the irreversible consumption of carbodiimide fuels. The anhydrides hydrolyse rapidly to the original dicarboxylates and are designed to assemble into hydrophobic colloids, hydrogels or inks. The spatiotemporal control over the formation and degradation of materials allows for the development of colloids that release hydrophobic contents in a predictable fashion, temporary self-erasing inks and transient hydrogels. Moreover, we show that each material can be re-used for several cycles.

Comment: Lots to say about this paper: a) To introduce prof. Boekhoven, whom I assure you you will hear about in the future, he is the perfect example of the product of the current Dutch system. b) This paper illustrates the importance on knowing how to put your papers in context, and the strong influence this context/presentation can have on where your research will be published. c) It highlights the value of thorough research and how a combination of fields can be helpful. Science-wise, it is an example of out-of-equilibrium systems, this time driving material properties using chemistry. Those are interesting because, mind you, everything living is out-of-equilibrium and the holy grail, a chemical and supramolecular oscillating system, is yet to be achieved. It is currently one of the most valuable fields of research both funding-wise and by level of publications. Some example: *Nature* **2016**, *537*, 656; *Nat. Nanotechnol* **2016**, *11*, 585; *Nat. Nanotechnol* **2015**, *10*, 111.

Combining 3D Printing with Electrospinning for Rapid Response and Enhanced Designability of Hydrogel Actuators

Chen, T.; Bakhshi, H.; Liu, L.; Ji, J.*; Agarwal, S.* *Adv. Funct. Mater.* **2018**, 1800514.

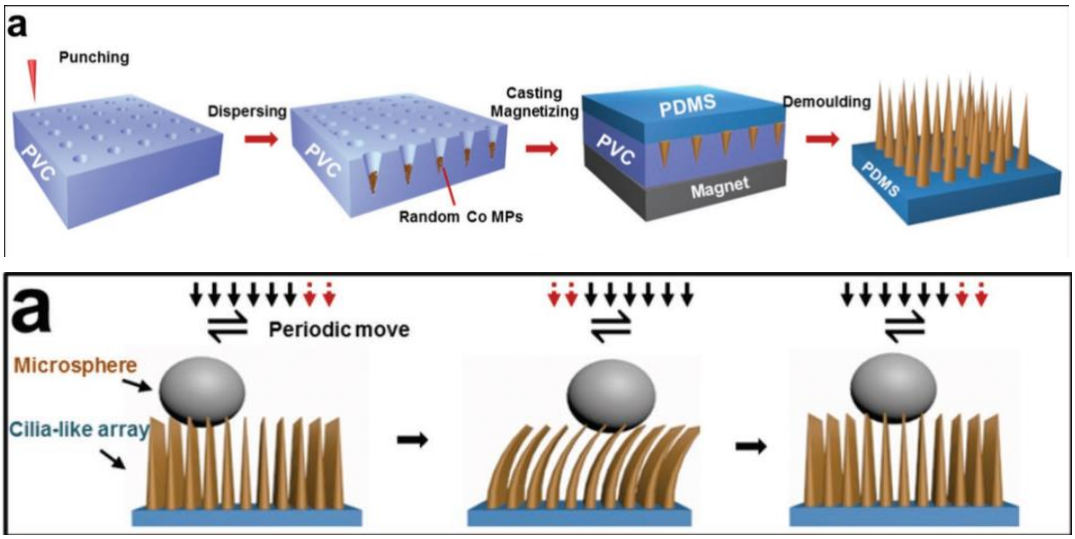


Porous structures have emerged as a breakthrough of shape-morphing hydrogels to achieve a rapid response. However, these porous actuators generally suffer from a lack of complexity and diversity in obtained 3D shapes. Herein, a simple yet versatile strategy is developed to generate shape-morphing hydrogels with both fast deformation and enhanced designability in 3D shapes by combining two promising technologies: electrospinning and 3D printing. Elaborate patterns are printed on mesostructured stimuli-responsive electrospun membranes, modulating in-plane and interlayer internal stresses induced by swelling/shrinkage mismatch, and thus guiding morphing behaviors of electrospun membranes to adapt to changes of the environment. With this strategy, a series of fast deformed hydrogel actuators are constructed with various distinctive responsive behaviors, including reversible/irreversible formations of 3D structures, folding of 3D tubes, and formations of 3D structures with multi low-energy states. It is worth noting that although poly (N-isopropyl acrylamide) is chosen as the model system in the present research, our strategy is applicable to other stimuli-responsive hydrogels, which enriches designs of rapid deformed hydrogel actuators.

Comment: a) With the help of computer-aided technology, elaborate patterns with maximum structure freedom to modulate shape-morphing processes are be generated by combining 3D printing with electrospinning. b) Can we incorporate motor-containing gels into electrospun membranes to construct elaborated hierarchical structures with responsiveness to light and temperature or other orthogonal stimuli?

Cilia-Inspired Flexible Arrays for Intelligent Transport of Viscoelastic Microspheres

Ben, S.; Tai ,J.; Ma, H.; Peng, Y.; Zhang, Y.; Tian, D.*; Liu, K.*; Jiang, L.; *Adv. Funct. Mater.* **2018**, 1706666.

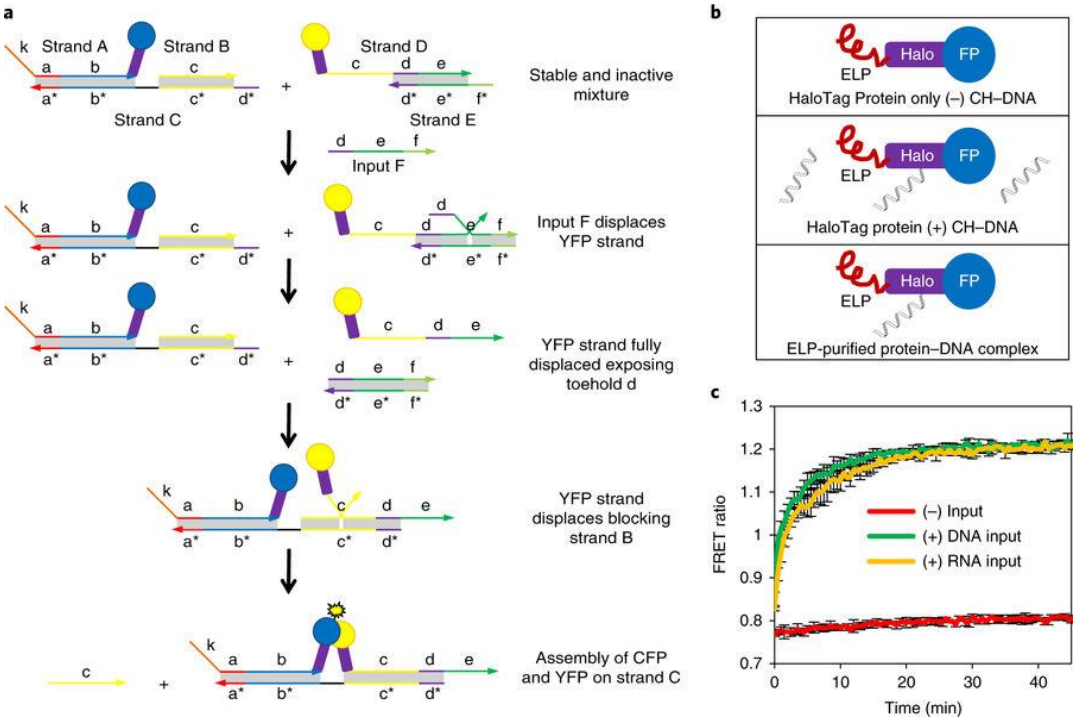


Anisotropic microstructures are widely used by being cleverly designed to achieve important functions. Mammals' respiratory tract is filled with dense cilia that rhythmically swing back and forth in a unidirectional wave to propel mucus and harmful substances out of the lung through larynx. Inspired by the **ciliary structure** and motion mechanism of the respiratory tract systems, a viscoelastic microsphere transporting strategy based on integration of airway cilium-like structure and magnetically responsive flexible conical arrays is demonstrated. Under external magnetic fields, the viscoelastic microspheres can be directionally and continuously transported alongside the swing of the cilia-like arrays that contain magnetic particles. This work provides a promising route for the design of advanced medical applications in directional transport of microspheres, drug delivery systems, ciliary dyskinesia treating, and self-cleaning without liquid.

Comment: An interesting bionic study about anisotropic micro/nanostructure arrays. Introducing electronic feedback response system to the reported example might bring a smarter system, which can "feel" the size and properties of the cargo it takes and to deliver it to its right destination.

Dynamic Protein Assembly by Programmable DNA Strand Displacement

Chen, R. P.; Blackstock, D.; Sun, Q.; Chen, W.* *Nat. Chem.* **2018**, *111*, 17486.

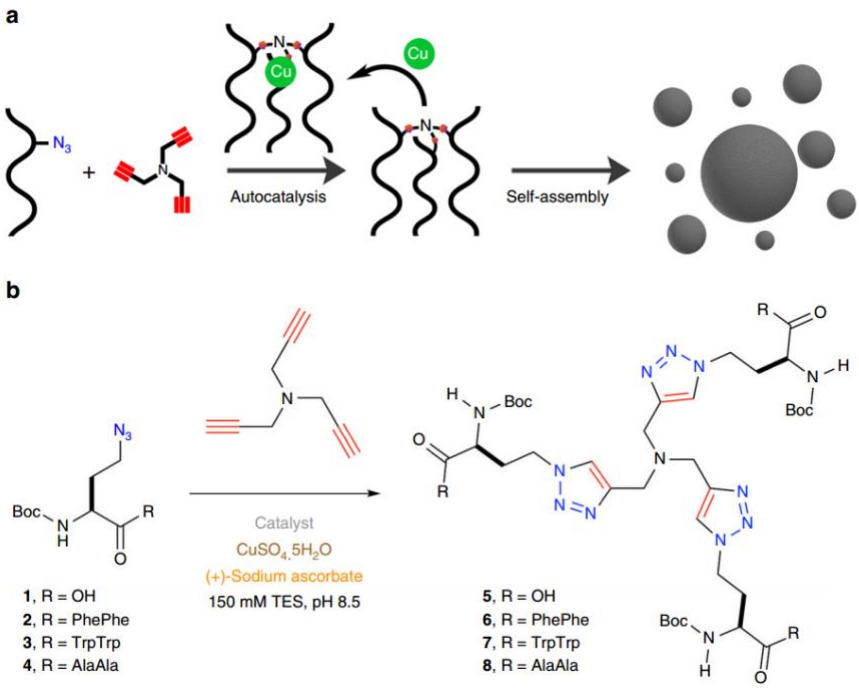


Inspired by the remarkable ability of natural protein switches to sense and respond to a wide range of environmental queues, here we report a strategy to engineer synthetic protein switches by using DNA strand displacement to dynamically organize proteins with highly diverse and complex logic gate architectures. We show that DNA strand displacement can be used to dynamically control the spatial proximity and the corresponding fluorescence resonance energy transfer between two fluorescent proteins. Performing Boolean logic operations enabled the explicit control of protein proximity using multi-input, reversible and amplification architectures. We further demonstrate the power of this technology beyond sensing by achieving dynamic control of an enzyme cascade. Finally, we establish the utility of the approach as a synthetic computing platform that drives the dynamic reconstitution of a split enzyme for targeted prodrug activation based on the sensing of cancer-specific miRNAs.

Comment: This paper presents a new dynamic combinatorial library (DCL) which involves a synthetic protein, DNA strands, and fluorescence resonance energy transfer (FRET). How can we transfer dynamic combinatorial chemistry from small molecules to simple biomolecules to mimic and control protein function and dynamics? It is a very big challenge.

Continual Reproduction of Self-assembling Oligotriazole Peptide Nanomaterials

Brea, R. J.; Devaraj, N. K.* *Nat. Commun.* **2017**, *8*, 730.

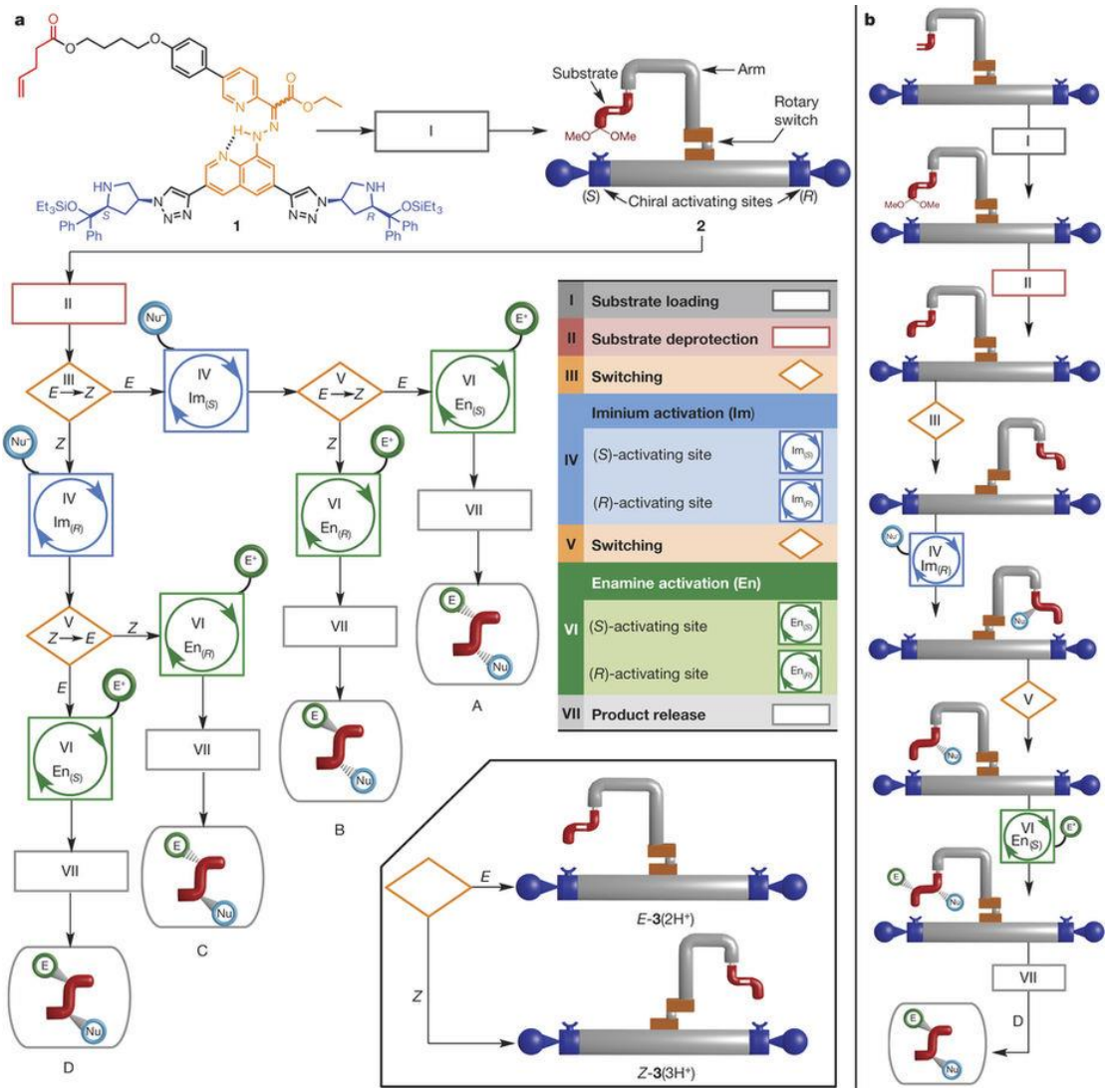


Autocatalytic chemical reactions, whereby a molecule is able to catalyze its own formation from a set of precursors, mimic nature's ability to generate identical copies of relevant biomolecules, and are thought to have been crucial for the origin of life. While several molecular autocatalysts have been previously reported, coupling autocatalytic behavior to macromolecular self-assembly has been challenging. Here, we report a non-enzymatic and chemoselective methodology capable of autocatalytically producing triskelion peptides that self-associate into spherical bioinspired nanostructures. Serial transfer experiments demonstrate that oligotriazole autocatalysis successfully leads to continual self-assembly of three dimensional nanospheres. Triskelion-based spherical architectures offer an opportunity to organize biomolecules and chemical reactions in unique, nanoscale compartments. The use of peptide-based autocatalysts that are capable of self-assembly represents a promising method for the development of self-synthesizing biomaterials, and may shed light on understanding life's chemical origins.

Comment: Although this autocatalytic chemical reaction only happens between peptides with three amino acids at most, the paper presents a seminal work on peptide nanomaterials which can undergo self-reproduction by coupling the ability of peptides to form diverse nanostructures with a highly efficient autocatalytic process.

Stereodivergent Synthesis with a Programmable Molecular Machine

Kassem, S.; Lee, A. T. L.; Leigh, D. A.*; Marcos, V.; Palmer, L. I.; Pisano, S. *Nature*, **2017**, *549*, 374–378.



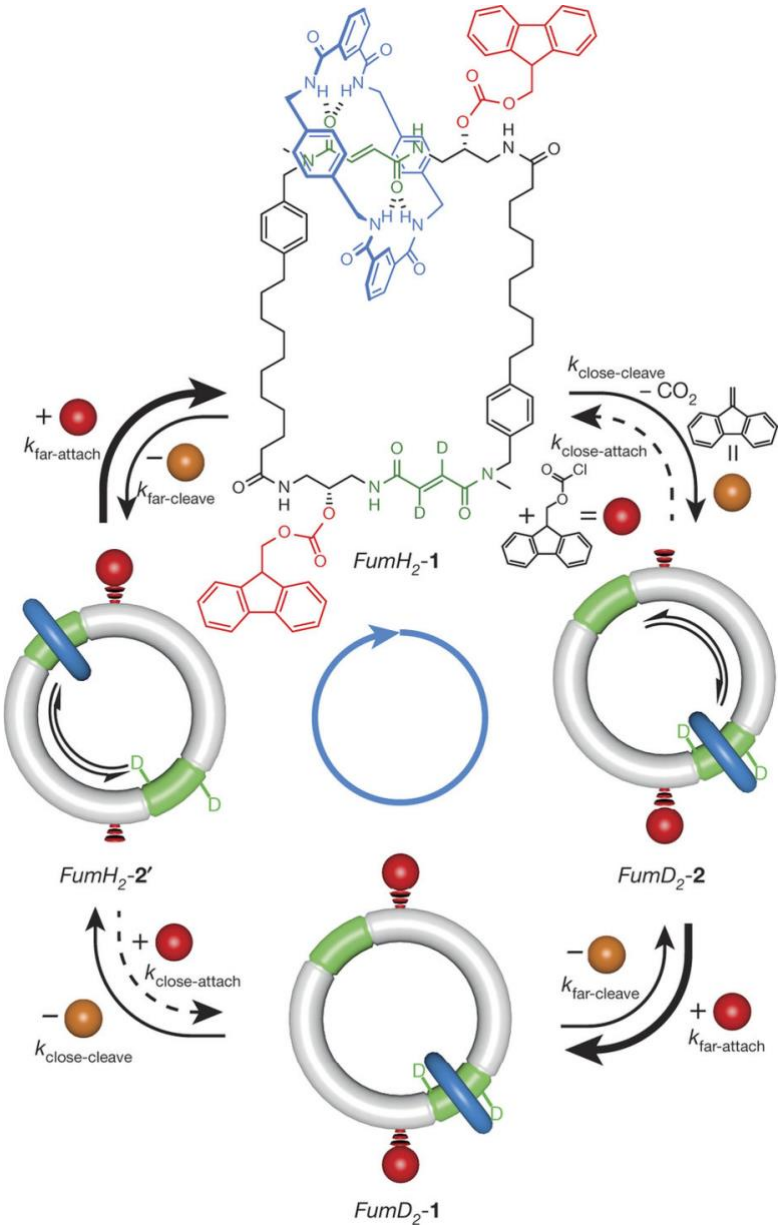
It has been convincingly argued that molecular machines that manipulate individual atoms, or highly reactive clusters of atoms, with Ångström precision are unlikely to be realized. However, biological molecular machines routinely position rather less reactive substrates in order to direct chemical reaction sequences, from sequence-specific synthesis by the ribosome to polyketide synthases where tethered molecules are passed from active site to active site in multi-enzyme complexes. Artificial molecular machines have been developed for tasks that include sequence-specific oligomer synthesis and the switching of product chirality, a photo-responsive host molecule has been described that is able to mechanically twist a bound molecular guest, and molecular fragments have been selectively transported in either direction between sites on a molecular platform through a ratchet mechanism. Here we detail an artificial molecular machine that moves a substrate between different activating sites to achieve different product outcomes from chemical synthesis. This molecular robot can be programmed to stereoselectively produce, in a sequential one-pot operation, an excess of any one of four possible diastereoisomers from the addition of a thiol and an alkene to an α,β-unsaturated aldehyde in a tandem reaction process. The stereodivergent synthesis includes diastereoisomers that cannot be selectively synthesized through

conventional iminium–enamine organocatalysis. We anticipate that future generations of programmable molecular machines may have significant roles in chemical synthesis and molecular manufacturing.

Comment: The molecular robot in this paper can be presented as the first generation of machines to manipulate substrates to control synthesis in a (new) form of mechanosynthesis.

An autonomous Chemically Fuelled Small-molecule Motor

Wilson, M. R.; Solà, J.; Carlone, A.; Goldup, S. M.; Lebrasseur, N.; Leigh, D. A.* *Nature* **2016**, *534*, 235.



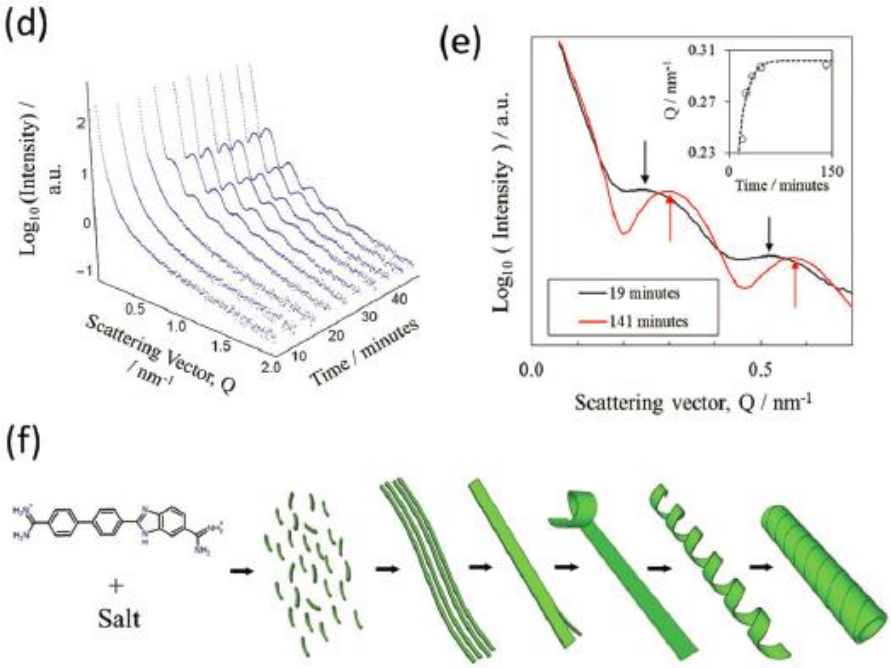
Molecular machines are among the most complex of all functional molecules and lie at the heart of nearly every biological process. A number of synthetic small-molecule machines have been developed, including molecular muscles, synthesizers, pumps, walkers, transporters and light-driven and electrically driven rotary motors. However, although biological molecular motors are

powered by chemical gradients or the hydrolysis of adenosine triphosphate (ATP), so far there are no synthetic small-molecule motors that can operate autonomously using chemical energy (that is, the components move with net directionality as long as a chemical fuel is present). Here we describe a system in which a small molecular ring (macrocycle) is continuously transported directionally around a cyclic molecular track when powered by irreversible reactions of a chemical fuel, 9-fluorenylmethoxycarbonyl chloride. Key to the design is that the rate of reaction of this fuel with reactive sites on the cyclic track is faster when the macrocycle is far from the reactive site than when it is near to it. We find that a bulky pyridine-based catalyst promotes carbonate-forming reactions that ratchet the displacement of the macrocycle away from the reactive sites on the track. Under reaction conditions where both attachment and cleavage of the 9-fluorenylmethoxycarbonyl groups occur through different processes, and the cleavage reaction occurs at a rate independent of macrocycle location, net directional rotation of the molecular motor continues for as long as unreacted fuel remains. We anticipate that autonomous chemically fuelled molecular motors will find application as engines in molecular nanotechnology.

Comment: This paper shows a fuel-driven small molecule with directional rotation. Directional rotation could be unequivocally established through a series of individually provable premises, a form of deductive logic commonly used in mathematical proofs.

Dynamic Self-assembly of DNA Minor Groove-binding Ligand DB921 into Nanotubes Triggered by an Alkali Halide

Mizuta, R.; Devos, J. M.; Webster, J.; Ling, W. L.; Narayanan, T.; Round, A.; Munnur, D.; Mossou, E.; Farahat, A. A.; Boykin, D. W.; Wilson, W. D.; Neidle, S.; Schweins, R.; Rannou, P.; Haertlein, M.; Forsyth, V. T.; Mitchell, E. P.* *Nanoscale, doi: 10.1039/C7NR03875E* .



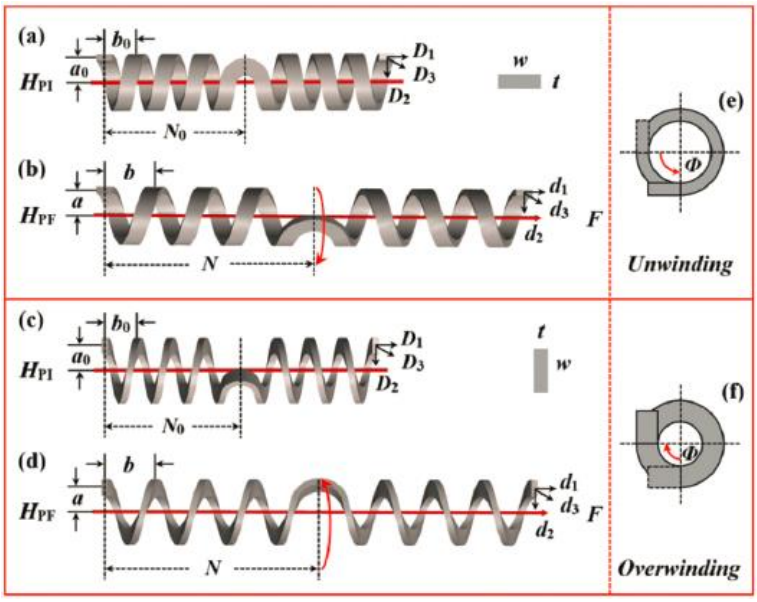
We describe a novel self-assembling supramolecular nanotube system formed by a heterocyclic cationic molecule which was originally designed for its potential as an antiparasitic and DNA sequence recognition agent. Our structural characterisation work indicates that the nanotubes form via a hierarchical assembly mechanism that can be triggered and tuned by well-defined concentrations of simple alkali halide salts in water. The nanotubes assembled in NaCl have inner and outer diameters of ca. 22 nm and 26 nm respectively, with lengths that reach into several

microns. Our results suggest the tubes consist of DB921 molecules stacked along the direction of the nanotube long axis. The tubes are stabilised by face-to-face π-π stacking and ionic interactions between the charged amidinium groups of the ligand and the negative halide ions. The assembly process of the nanotubes was followed using small-angle X-ray and neutron scattering, transmission electron microscopy and ultraviolet/visible spectroscopy. Our data demonstrate that assembly occurs through the formation of intermediate ribbon-like structures that in turn form helices that tighten and compact to form the final stable filament. This assembly process was tested using different alkali-metal salts, showing a strong preference for chloride or bromide anions and with little dependency on the type of cation. Our data further demonstrates the existence of a critical anion concentration above which the rate of self-assembly is greatly enhanced.

Comment: This work used time-resolved SAXS to gives clear and comprehensive dynamic analysis of tubes forming process, which is cool. I think we can also use this method to study the self-assembly of TPAs.

Controllable Rotational Inversion in Nanostructures with Dual Dhirality

Dai, L.*; Zhu, K.-D.; Shen, W.; Huang, X.; Zhang, L.*; Goriely, A. *Nanoscale, doi: 10.1039/C7NR09035H*.



Chiral structures play an important role in natural sciences due to their great variety and potential applications. A perversion connecting two helices with opposite chirality creates a dual-chirality helical structure. In this paper, we develop a novel model to explore quantitatively the mechanical behavior of normal, binormal and transversely isotropic helical structures with dual chirality and apply these ideas to known nanostructures. It is found that both direction and amplitude of rotation can be finely controlled by designing the cross-sectional shape. A peculiar rotational inversion of overwinding followed by unwinding, observed in some gourd and cucumber tendril perversions, not only exists in transversely isotropic dual-chirality helical nanobelts, but also in the binormal/normal ones when the cross-sectional aspect ratio is close to 1. Beyond this rotational inversion region, the binormal and normal dual-chirality helical nanobelts exhibit a fixed directional rotation of unwinding and overwinding, respectively. Moreover, in the binormal case, the rotation of these helical nanobelts is nearly linear, which is promising as a possible design for linear-to-rotary motion converters. The present work suggests new designs for nanoscale devices.

Comment: This work studies the mechanical properties of helical nanostructures with dual chirality. It's more a physical study, but it is getting more and more important to know the physical properties of nanostructures and we should learn from it.

Big Potential from Small Agents: Nanoparticles for Imaging-Based Companion Diagnostics

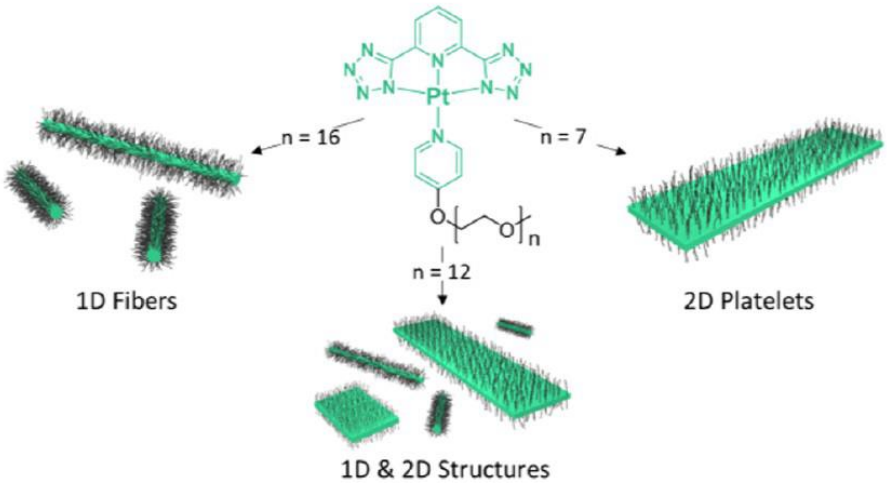
Ehlerding, E. B.; Grodzinski, P.; Cai, W.; Liu, C. H.* *ACS Nano*, **2018**, *ASAP*.

The importance of medical imaging in the diagnosis and monitoring of cancer cannot be overstated. As personalized cancer treatments are gaining popularity, a need for more advanced imaging techniques has grown significantly. Nanoparticles are uniquely suited to fill this void, not only as imaging contrast agents but also as companion diagnostics. This review provides an overview of many ways nanoparticle imaging agents have contributed to cancer imaging, both preclinically and in the clinic, as well as charting future directions in companion diagnostics. We conclude that, while nanoparticle-based imaging agents are not without considerable scientific and developmental challenges, they enable enhanced imaging in nearly every modality, hold potential as in vivo companion diagnostics, and offer precise cancer treatment and maximize intervention efficacy.

Comment: A nice review about the use of nanoparticles for imaging. It summarizes the advances in this field sorting by type of nanoparticles as well as by imaging techniques. It's obviously quite far from the research in the SAMS group, but I'm sure many of you have to deal sometimes with friends talking about nanorobots that could heal us in the future…

Dimensional Control and Morphological Transformations of Supramolecular Polymeric Nanofibers Based on Cofacially-Stacked Planar Amphiphilic Platinum(II) Complexes

Robinson, M. E.; Nazemi, A.; Lunn, D. J.; Hayward, D. W.; Boott, C. E.; Hsiao, M.-S.; Harniman, R. L.; Davis, S. A.; Whittell, G. R.; Richardson, R. M.; De Cola, L.; Manners, I.*
ACS Nano. **2017**, *11*, 9162-9175.



Square-planar platinum(II) complexes often stack cofacially to yield supramolecular fiber-like structures with interesting photophysical properties. However, control over fiber dimensions and the resulting colloidal stability is limited. We report the self-assembly of amphiphilic Pt(II) complexes with solubilizing ancillary ligands based on polyethylene glycol [PEG_n, where n = 16, 12, 7]. The complex with the longest solubilizing PEG ligand, Pt-PEG_{16}, self-assembled to form polydisperse one-dimensional (1D) nanofibers (diameters <5 nm). Sonication led to short seeds which, on addition of further molecularly dissolved Pt-PEG_{16} complex, underwent elongation in a "living supramolecular polymerization" process to yield relatively uniform fibers of length up to ca. 400 nm. The fiber lengths were dependent on the Pt-PEG_{16} complex to seed mass ratio in a manner analogous to a living covalent polymerization of molecular monomers. Moreover, the fiber lengths were unchanged in solution after 1 week and were therefore "static" with respect to interfiber exchange processes on this time scale. In contrast, similarly formed near-uniform fibers of Pt-PEG_{12} exhibited dynamic behavior that led to broadening of the length distribution within 48 h. After aging for 4 weeks in solution, Pt-PEG_{12} fibers partially evolved into 2D platelets. Furthermore, self-assembly of Pt-PEG_7 yielded only transient fibers which rapidly evolved into 2D platelets. On addition of further fiber-forming Pt complex (Pt-PEG_{16}), the platelets formed assemblies via the growth of fibers selectively from their short edges. Our studies demonstrate that when interfiber dynamic exchange is suppressed, dimensional control and hierarchical structure formation are possible for supramolecular polymers through the use of kinetically controlled seeded growth methods.

Comment: This paper deals with something that is often overlooked: **the dynamic of evolution of self-assembled structures over time**. Sometimes we just don't give our systems the good conditions to self-assemble before imaging them. See for instance the platelets of Pt-PEG_{12} aged for 4 weeks!