Making the Tiniest Machines

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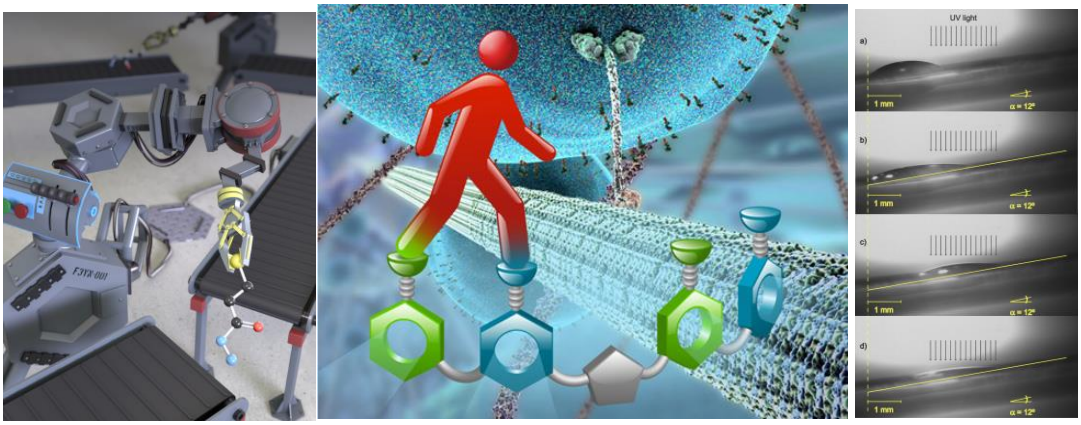
Over the past two decades some of the first examples of synthetic molecular level machines and motors—all be they primitive by biological standards—have been developed. Perhaps the best way to appreciate the technological potential of controlled molecular-level motion is to recognise that nanomotors and molecular-level machines lie at the heart of every significant biological process. Over billions of years of evolution Nature has not repeatedly chosen this solution for achieving complex task performance without good reason. When we learn how to build artificial structures that can control and exploit molecular level motion, and interface their effects directly with other molecular-level substructures and the outside world, it will potentially impact on every aspect of functional molecule and materials design.



Selected papers:

• "*Rotary and linear molecular motors driven by pulses of a chemical fuel*" *Science* **358**, 340-343 (2017) • "*Stereodivergent synthesis with a programmable molecular machine*" *Nature* **549**, 374-378 (2017) • "*Braiding a molecular knot with eight crossings*" *Science* **355**, 159-162 (2017) • "*An autonomous chemically fuelled small-molecule motor*" *Nature* **534**, 235-240 (2016) • "*Allosteric initiation and regulation of catalysis with a molecular knot*" *Science* **352**, 1555-1559 (2016) • "*Pick-up, Transport and Release of a Molecular Cargo using a Small-Molecule Robotic Arm*" *Nature Chem.* **8**, 138-143 (2016) • "*A Star of David Catenane*" *Nature Chem.* **6**, 978-982 (2014) • "*Sequence-Specific Peptide Synthesis by an Artificial Small-Molecule Machine*" *Science* **339**, 189-193 (2013) • "*A Synthetic Molecular Pentafoil Knot*" *Nature Chem.* **4**, 15-20 (2012) • "*A Single Synthetic Small Molecule that Generates Force Against a Load*" *Nature Nanotech.* **6**, 553-557 (2011) • "*A Synthetic Small Molecule That Can Walk Down a Track*" *Nature Chem.* **2**, 96-101 (2010) • "*Operation Mechanism of a Molecular Machine Revealed Using Time-Resolved Vibrational Spectroscopy*" *Science* **328**, 1255-1258 (2010) • "*Hybrid Organic-Inorganic Rotaxanes and Molecular Shuttles*" *Nature* **458**, 314-318 (2009) • "*A Molecular Information Ratchet*" *Nature* **445**, 523-527 (2007) • "*Macroscopic Transport by Synthetic Molecular Machines*" *Nature Mater.* **4**, 704-710 (2005) • "*A Reversible Synthetic Rotary Molecular Motor*" *Science* **306**, 1532-1537 (2004) • "*Unidirectional Rotation in a Mechanically Interlocked Molecular Rotor*" *Nature* **424**, 174-179 (2003) •