DIY materials will allow scientists and engineers to re-make the world

Human development has been based on making the best possible use of natural materials and resources - initially plants, wood, stone and metals, before the evolution of man-made materials such as plastics.

All of these kinds of materials have had their strengths and their limitations: in weight, size, fragility, elasticity, ability to degrade and essential scarcity. As a result, societies have needed to make the best of the materials available - just muddling through - leading to major global environmental problems (such as pollution and carbon emissions from the use fossil fuels; deforestation; soil erosion; the accumulations of plastic waste; inefficiencies in performance and availability).

Advances in molecular science have opened up the potential for starting from scratch in the creation of new materials and in improving the old. That means the control and direction of the assembly of molecules so precisely that we can develop and prepare materials with highly sophisticated and ‘tuneable’ properties.

Re-making the building blocks of materials will allow for the development of, for example: new energy sources; sustainable alternatives to many scarce materials (like the rare and precious metals used in electronics devices); personalised healthcare (bespoke medicines and implants); smart, energy efficient materials for the construction industry; better means of capturing pollutants; more efficient, lighter materials that allow for more low energy and solar-powered vehicles; extend the lifetimes of foodstuffs; low-cost superconductors, and in general, the optimisation of the efficiency of any existing natural materials. An important related area is disassembly - how the new used materials can be re-used, biodegrade and not have an impact on the environment.

A spearhead for work in the area is the UK’s Directed Assembly Grand Challenge Network, set up by the Engineering and Physical Sciences Research Council (EPSRC) in 2010 with a 20–50 year vision for developing and delivering the science and applications. The Network has grown to include more than 1,000 chemists, biologists, physicists, chemical engineers, mathematicians, and computer scientists from academia and industry. Around a quarter are early career academics, looking to be involved in driving long-term projects Over £325,000 of Directed Assembly Network pump-priming, travel and seedcorn grants were awarded between 2012 and 2016. These, along with over 45 meetings during this period have led to over 80 new collaborations. More than £50 million of major grants and fellowships are directly linked to and/or are supported by the network’s activities and awards.

Cranfield University has a lead role in the latest phase of the Directed Assembly Network, which currently extends to the translation and scale-up of newly assembled or disassembled materials in order for them to be of direct use to industry. The new formulation methods and scale-up will

support existing and emerging industries, and there will be a specific focus on material and device design for new high tech applications to support emerging technologies. Chemists, engineers and practitioners are brought together to explore and define the pathways for the translation of those scientific discoveries for potential future application and manufacturing. Work also includes interaction with industry and end-users in order to identify needs and address particular engineering and industry challenges, and to look at the particular challenges involved in manufacturing processes with the new materials. In this way the Directed Assembly Network will speed the uptake of new technologies into production processes and encourage industry collaboration in R&D, providing a boost to economic growth and wider social prosperity.

Harris Makatsoris
Cranfield University, Cranfield, MK43 0AL, United Kingdom

Publication

Directed Assembly Network phase three launch: a round-up of success to date and strategy for the future.
Rose JAR, Raithby PR, Makatsoris C
Chem Cent J. 2017 Aug 4