Programming the Assembly of Inorganic Nanomaterials Using Networked Chemical Reactions

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Traditionally much of nanochemical synthesis and self-assembly and transformations have been done in one pot reaction systems whereby reagents are added and the reaction conditions are controlled in terms of temperature, solvent, atmosphere and pressure. Although this general approach has been incredibly successful for the bottom up assembly of nanomaterials, the manipulation of programming of complex nanomaterials via reaction networks and the development of systems showing emergent properties require a fundamentally new approach, see Figures 1 and 2.

![Figure 1](image1.jpg)

Figure 1. LEFT shows a schematic of the reaction array that can be set up by the continuous flow of reagent inputs (S₁–S₉) and the reaction array rₘ that results from the screening of the inputs against each other. RIGHT shows a photograph of the set up.

![Figure 2](image2.jpg)

Figure 2. RIGHT shows a schematic of the networked reactor array (from reagent inputs Sₙ) where different reactions Rₙ can be ‘networked’ or interconnected at different times during the process. RIGHT shows a photograph of the set up.
In this contribution I will outline our recent efforts, investigating the self-assembly and self-organization of inorganic nano molecules and the engineering of complex systems and reaction networks that lead to the emergence of system-level behaviours of interacting nanomolecules. To do achieve this we have developed new reaction techniques to control the assembly of nanoscale molecular metal oxide clusters, some of the largest non-biological molecules known, as well as new physical techniques e.g. the development of new cryospray and variable temperature mass spectrometry (for the elucidation of reaction mechanism and the observation of highly reactive intermediates). Ultimately our aim is to develop minimal inorganic systems capable of evolution, engineering materials with complex and emergent behaviours, as well as the development of new reaction formats for complex and novel chemistry e.g. flow systems and 3D-printing[1-5].

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References


