Dynamic Molecular Control of Nanomaterials

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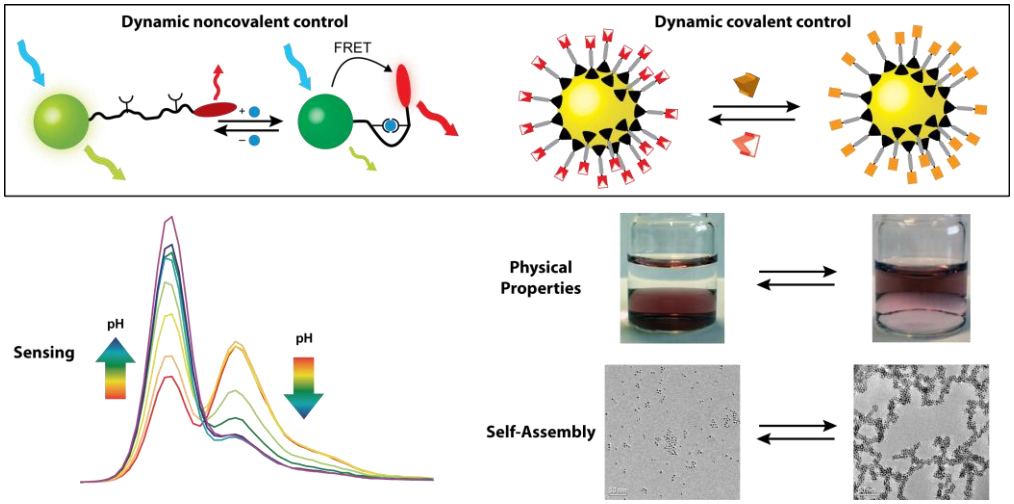
Today the preparation of pure, nearly monodisperse and stable nanoparticles (NPs) has been achieved for a variety of materials, revealing a host of unique and potentially useful properties that are tuneable according to NP constitution, size and shape. Virtually all emerging or proposed applications that would seek to harness this newfound region of chemical space will require the integration of NPs with each other, with molecules, or with micro and macroscopic components (or most likely a combination of these). Yet, our ability to control and interrogate NP functionalization and assembly has so-far failed to keep pace with the developments in their synthesis.

Dynamic and stimuli-responsive molecular systems present a powerful opportunity for addressing these issues. At the same time, interfacing complex functional molecules with nanomaterials raises several questions of intrinsic scientific interest.

I will discuss the application of dynamic molecular systems to control NP properties, functionalization and assembly and will present our ongoing efforts to understand the fundamental characteristics of the NP–molecule interface. The preparation of NPs bearing dynamic covalent surface functionality will be presented, including characterization at the molecular level that reveals how confinement to the NP surface affects reactivity. I will show how dynamic covalent NP-bound monolayers may be used to reversibly control NP physical properties, and also to direct the self-assembly of NP building blocks. Combining the error-correcting and stimuli-responsive features of equilibrium processes with the stability and structural diversity provided by covalent chemistry will ultimately lead to a new generation of stimuli-responsive NP devices and materials with precisely positioned NP and molecule components.



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Euan Kay received his MChem degree from the University of Edinburgh in 2002. He was awarded a Carnegie Scholarship and remained in Edinburgh to work under the supervision Prof. David A. Leigh FRS, receiving his Ph.D. in 2006. His doctoral studies focused on developing and demonstrating mechanisms for controlling molecular-level motion, introducing the first examples of 'compartmentalized' synthetic molecular machines in the form of hydrogen-bond assembled catenanes and rotaxanes. For this work, Dr Kay was awarded a 2007 IUPAC Prize for Young Chemists.

Following a period of post-doctoral work in Edinburgh, Kay was awarded an 1851 Research Fellowship in 2008 and joined the laboratory of Prof. Moungi Bawendi at the Massachusetts Institute of Technology. There, he worked on interfacing molecular machines with semiconductor quantum dots to develop new strategies for the design of nanocrystal-based fluorescent sensors.

In 2011, Dr Kay was awarded a Royal Society of Edinburgh / Scottish Government Fellowship and moved to the University of St Andrews. There, his research seeks to extend dynamic and stimuli-responsive molecular systems into the nanoworld so as to achieve new levels of control over the functionalization and assembly of nanomaterials.