DISCOVERY, APPLICATIONS AND SCALE-UP OF BIOINSPIRED NANOMATERIALS

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Inorganic nanomaterials are widely used in industry and in consumer products with a global production of the order of several million tons per annum and worth several $billions. Current methods for nanomaterials synthesis or manufacturing suffer from significant environmental burden leading to high costs and unsustainable production. In contrast, biological organisms, through biomineralisation, produce elaborate and ordered nanomaterials under physiological conditions. Learning from organisms, we have developed green nanomaterials (GN) synthesis (Figure 1).[1] This green method (mild, one-pot and rapid synthesis in water, at room temperature and neutral pH) offers substantial reductions in resources, time and energy usage when compared to traditional routes, yet offers excellent control over the properties and function of the materials. This presentation will illustrate how key synthetic parameters were identified systematically using Design of Experiments in order to modulate silica formation, its physicochemical properties and its function. Furthermore, experimental results and techno-economic analysis of manufacturing using this new process will be discussed.[2-4] This includes our systematic approach in terms of both process scale-up and process intensification. These results suggested that the process operates well in both batch and continuous mode in tank and tubular reactors. We have also focused on some aspects of downstream processing, in particular, purification of the products, allowing a complete removal of organics, with an added possibility of composition and porosity control. Given that this is a non-destructive method, >90% water and additive can be recycled, further improving the sustainability and economics.[4]

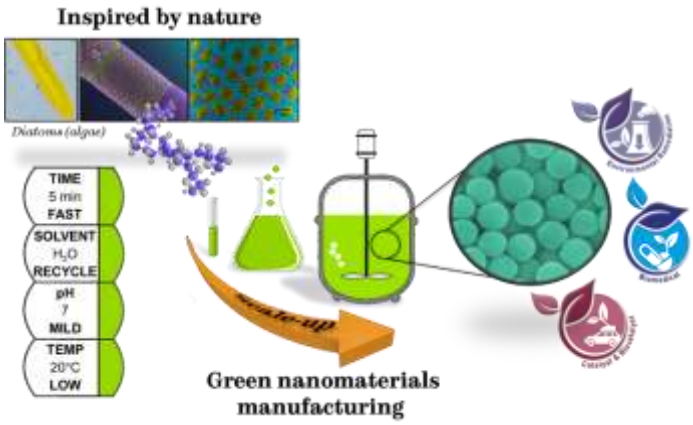

Figure 1 – An overview of the bioinspired approach taken for developing green nanomaterials. Image reproduced from ref. 1.

We are developing green nanomaterials for a wide variety of applications (e.g. energy storage,[5] carbon capture & sequestration,[6] environmental remediation,[7] biocatalysis[8] and drug delivery[9]). This presentation will conclude by summarising how bioinspired routes can help design sustainable manufacturing technologies for high value nanomaterials and identifying future challenges and focus areas.

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