

Directed Assembly of Pre-Programmed Building Blocks at the Mesoscale

Opportunity

One of the grand challenges in material sciences is the synthesis of “designer materials” where pre-programmed building blocks (i.e. nanomaterials) are used to create both simple and complex multi-component materials ***predictively***, enabling desired properties and functions.

Precise control during assembly of pre-programmed building blocks from the nanoscale to the mesoscale will lead to a new class of materials with abilities to manipulate and design emerging properties.

Approach

Dynamic synthesis and assembly approach to rapidly synthesize, characterize, screen/separate and assemble nanomaterials with integrated *in-situ* characterization tools to provide real-time feedback. The dynamic synthesis and assembly approach will provide the ability to fine tune the reaction parameters in real-time to rapidly obtain desired materials and manipulate the assembly process. Tremendous advances in the synthesis/characterization of nanomaterials in recent years can provide a solid foundation for controlling and assembling nanomaterials at the mesoscale.

Meso Challenge

- 1) How can we control and manipulate nanomaterials’ interactions precisely and predictively?
- 2) How can we understand and alter the interfacial energy landscapes of nanomaterials?
- 3) How can we predictively assemble in mesoscale to give rise to unique functions?

Impact

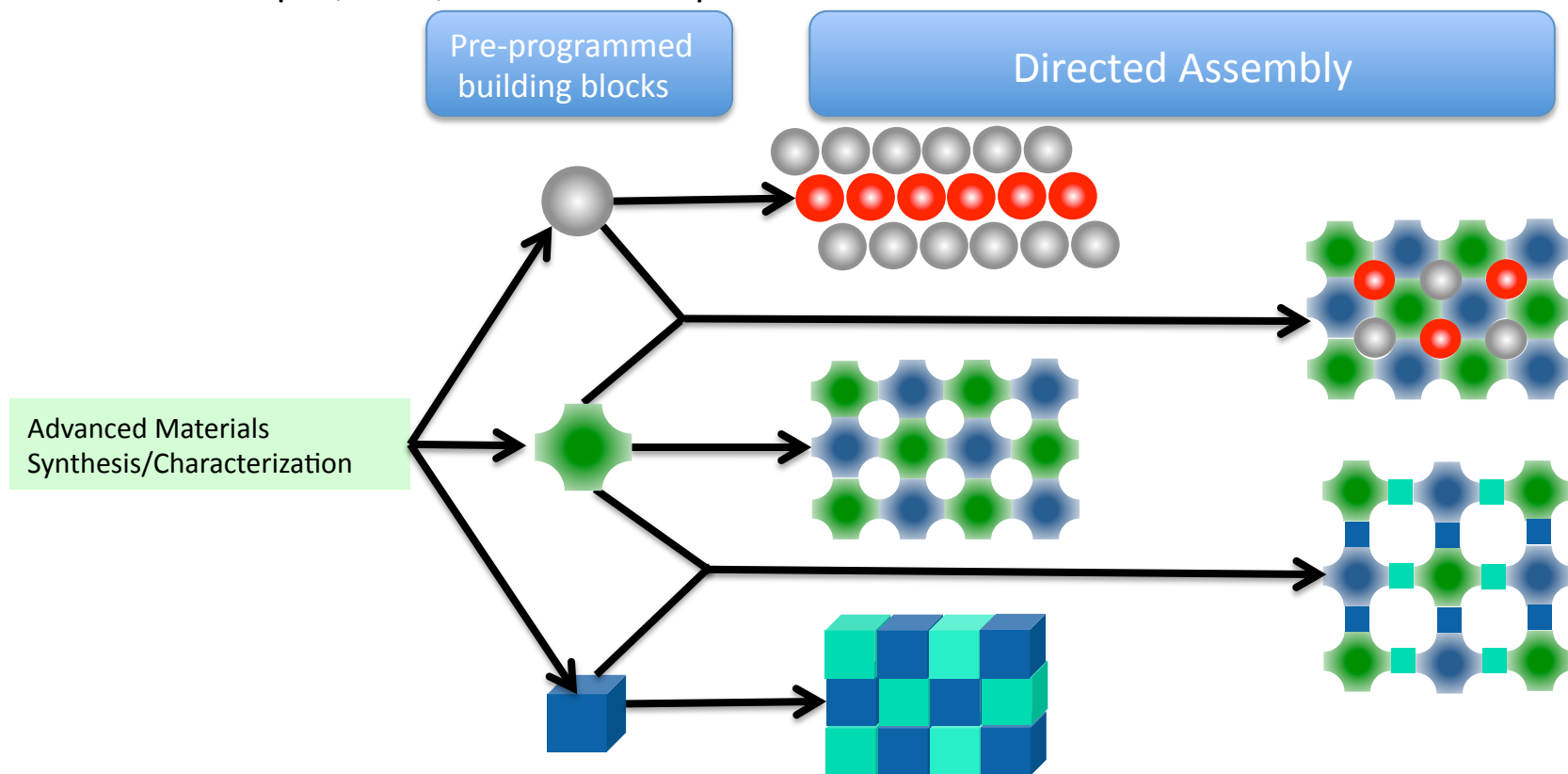
Directed assembly of nanomaterials can predictively create new multi-component 3-dimensional composite materials with emerging functionalities and properties (i.e. electronic, mechanical, optical, catalytic and magnetic, etc.) that can be manipulated. This new class of materials can impact many application fields and technologies such as catalysts for CO₂ and CH₄ to liquid fuels and battery materials.



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Motivation: Precise control of nanomaterials assembly from the nanoscale to macroscale will lead to a new class of materials with abilities to manipulate and pre-program the emerging properties.

Pre-programmed building blocks = nanomaterials (both organic and inorganic) with different shapes, sizes, chemical composition and surface functionalities.



* Different colors indicate different chemical compositions/surface functionalities



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