Editorial corner – a personal view

Biomimetic materials: A challenge for nano-scale self-assembly

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Structural and performance efficiency is evident throughout nature. Natural materials are a basis for materials design; because they have evolved creating properties that suit particular or diverse environments. Replicating natural materials is a strategy for designing optimally performing materials. There are several routes to biomimicry: 1) use biomaterials: minerals, wood and natural fibres directly in composites, 2) adapt natural processes: layer-by-layer formation, orientation and self-assembly to synthetic materials, 3) form synthetic or semi-synthetic structures that replicate natural morphologies. A further dimension is scale. Preparation of biomimetic materials has trended towards nano-scale where components, morphology and techniques are combined. Nano-dimensions provide large interfaces and structural perfection. Articles in *EXPRESS POLYMER LETTERS* present developments in biomimetic polymer materials that attract much interest.

Material design, processing and component selection are requirements of characterisation techniques, with sensitivity and resolution at the nano-scale. X-ray scattering and transmission electron microscopy are theoretically suited. Surface force microscopy is a collection of techniques with growing specificity. The diffraction limitation of optical microscopy is circumvented with fluorescent nano-imaging adaptations. Infrared and Raman microscopy are emerging with nano-scale variants. Computation and interpretation of data from standard structure–property techniques provide indirect or inferred information about nano-materials.

Most natural structural materials are composites, since component properties are retained, not averaged, and incongruous properties: hardness, tough-

ness and strength are achieved simultaneously. Nacre is tough, hard and strong, yet it contains mainly calcium carbonate with minimal organic binder. Multi-phase composites that contain platelets or fibrous inclusions focus anisotropic performance, with orientation imposed by processing or self-association. Natural materials are often not space-filling; they contain voids interspersed with structural regularity, commonly hexagonal features. Some voids are channels to convey nutrients to the living system. Synthetic analogies are foams and membranes. Foams decrease density more than mechanical properties, while membranes are functional materials. Foam, honeycomb and cantilevered structures are prepared, though they present most challenge at the nano-scale. Finite element modelling predicts that uniform strength is unnecessary; stress must be effectively transferred from regions of stress concentration.

Biomimetic concepts have expanded to self-repair, typically containing reagent microcapsules or reversible reaction functionality. A living system with channels to convey repairing substances is an analogy, though in a renewable material a complexity is removal of damaged materials from repair sites to allow continued renewal. Can micro or nano bricks and mortar structures be prepared and controlled though self-assembly, including self-repair?

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