Natural fibrous proteins as a source for inspiration for the design of novel nano-biomaterials

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Natural fibrous proteins include families found in natural materials such as wool, silk, in tissue components such as collagen, elastin or in virus and bacteriophage adhesins [1]. They have long fascinated scientists and engineers due to their mechanical and elastic properties, and considerable efforts have been made in order to produce artificial materials inspired from these natural proteins. Repetitive sequences, or "building blocks" derived from these fibrous proteins can self-assemble into well-defined structures (wires, tubes etc.) under mild conditions and are relatively inexpensive and easy to manufacture [2]. Of particular interest is the possibility of using these peptide nanofibers and nanotubes as templates for the growth of inorganic materials, such as metals, semiconductors, silica, etc.

We have been involved for a number of years in the rational design, synthesis and characterization of self-assembling proteins and peptides following identification of building blocks in viral fibers. This previous work resulted in the identification of a minimal, octapeptide building block that self-assembles into fibrils, and these fibrils have recently been used as templates for the growth of inorganic materials [3, 4]. Controlled manipulation, positioning and nano-microfabrication of self-assembled protein and peptide materials remain a bigger challenge than their design and production. In collaboration with IESL colleagues, we have been using laser - fabricated scaffolds for their controlled positioning [5]. These primary laser-fabricated scaffolds with attached secondary peptide scaffolds could then be used as a support for the directed growth of cells into biomineralized units [6].

I will describe how structural insight and basic biochemical studies, combined with practical integration approaches, can result in materials applications ranging from the nano- to the macro-scale.

References

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