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Introduction to bioinspired materials: Design, processing and applications

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Abstract

Biomimicking has been practiced since the dawn of civilization, evidenced by adobe bricks dated back millennia ago. One vivid example is flight, inspired by flapping wings of birds, realizing the dream of novelist who depicted kings on their thrones being carried in the sky by four vultures flapping their wings trying to reach dangling pieces of meat hung above their heads. In this chapter, an introduction to the field of bioinspired materials is presented beginning with the flight of Otto Lilienthal in Germany followed by the meaning of bioinspired materials. In the third section, the readers get familiar with the applications of bioinspired polymers and related soft materials including thin film biocatalysts, polymeric supports, antibodies, protamine immobilizers, and bioactive compounds. More specific applications of biomimetics in the field of materials are presented in the fourth section where self-healing materials are discussed along with the role of friction in triggering self-healing action. Microstructure-based weakening due to precipitation, self-healing metallic and metal matrix composites, self-lubricating materials, self-organizing tribological systems and self-cleaning materials similar to lotus effect are topics presented in the fourth section. The following section is focused on the application of biomimicking in architecture. An example included in the fifth section is a termite mound as a natural structure with elevation channels that provide air circulation. In the sixth section, discussion is concentrated on self-generated forms inspired by nature which preludes a major area of research into biomimicked construction providing insight in the enhanced mechanical properties of composites modeled after nacre. The seventh section is dedicated to the advances in bioinspired medical materials including their synthesis, and their crossing size scales down to nanomaterials and nanocomposites inspired by nature. Mimicking marine life leading to the development of bioinspired sonar systems and active electro location inspired by weak electric fish concludes the chapter ending with a summary at the end.

Key Words: Bioinspired, biomimetics, bioinspired materials, biomimicked, biomimicry, copying nature, nature-inspired, inspired by biology, bioinspiration, smart materials, bioengineering