Bio-Inspired Smart Materials, Interfaces, and Sensing Systems

The contributions in this issue of Big.D explore how principles derived from biological systems can inform the engineering of smart materials, adaptive surfaces, sensing technologies, wearable interfaces, and health-monitoring systems.

A central theme is the translation of biological structures into engineered functional performance. Investigations of Boston ivy adhesion, bio-inspired thermochromic coatings, superhydrophobic surfaces, and dragonfly-inspired wind-turbine microstructures demonstrate how biological morphology and hierarchical organization can provide models for adhesion, optical or thermal response, surface protection, and aerodynamic performance. Importantly, these studies combine biological inspiration with quantitative biomechanical analysis, material characterization, numerical modeling, or experimental validation.

The issue also highlights the development of adaptive and multifunctional sensing interfaces. Self-powered bionic sensing textiles, photo-driven flexible sensor arrays, smart textile surfaces for chronic-wound monitoring, and hierarchical adhesive interfaces for physiological monitoring demonstrate the increasing integration of materials engineering, structural design, sensing, and intelligent monitoring. Such technologies illustrate how engineered interfaces can become more conformable, responsive, and closely coupled with the human body.

Biomedical miniaturization provides another important direction. A bionic gut-on-a-chip platform extends biomimetic engineering toward the reconstruction and monitoring of complex biological microenvironments, demonstrating the potential of design-enabled engineering at micro- and system scales.

The issue also includes computational investigation of neural dynamics associated with digital-interface interaction, connecting intelligent analysis with the growing field of human-centered and neuro-informed design.

Collectively, these contributions show that bio-inspired engineering is evolving from observation toward functional translation and system integration. By connecting biological principles with advanced materials, fabrication, sensing, computation, and validation, the studies in this issue exemplify the interdisciplinary engineering approach that lies at the core of Big.D.