MIXING AND MATCHING
MATERIALS

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The world we interact with is dominated by intertwined materials known as composites. Unlike in metal alloys or polymer blends, where the atoms or molecules are intimately mixed, components of a composite material retain their individual identities, and their careful selection and combination maximizes certain sets of properties. Here, too, another facet of composite materials emerges—they typically have stronger and weaker directions (i.e., asymmetric properties), as they are designed to fulfill the needs of specific applications.

The benefits of combining materials are easily learned from nature. Natural composites such as nacre, wood, and teeth have impressive properties arising from their hierarchical structures, especially as they are generated from easily obtained starting materials that often have limited capabilities. Though scientists have long studied mechanically tough natural composites, recent research has shown that biological sponges transform materials as simple as silica into components that are both tough and exceptionally efficient at manipulating light. Further, natural materials, many of which end up as waste in the process of harvesting food, may have properties that can compete with those of synthetic materials and have the advantage of originating from renewable resources.

Carbon-based composites such as those fabricated from carbon fiber offer the unique combination of high strength and low density. Replacing carbon fiber with graphene or carbon nanotubes opens a wide range of new properties for optimization. The potential to develop composites with exceptional mechanical, thermal, and electrical properties provides great incentive to overcome processing hurdles to efficient production scale-up.

In all good composites, the whole is better than the sum of the parts. The same may be true of research on composites, as looking beyond one's traditional sources of materials may lead to better composite materials.

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Squid sucker teeth are strong enough to pierce and anchor prey but are composed solely of protein building blocks that can be reshaped upon heating.

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