HANDBOOK OF ADVANCED MATERIALS
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The use of improved materials enables engineers to design new and better products and processes. Benefits include increased sales of improved products and, where new materials are used in manufacturing, reduced plant cost. Society benefits through the use of improved products that use these new materials.

Sophisticated new materials save lives (artificial hearts, shatterproof glass, bulletproof vests), conserve energy (lightweight cars) and expand human horizons (aircraft, spacecraft, computers through the World Wide Web). In the twenty-first century a new generation of materials promises to again reshape our world and solve some of the planet’s most pressing problems. Although there is a tremendous array of materials, this book focuses on so-called advanced materials, especially those offering the latest advancements in properties. They are materials of construction with exceptional properties enabling improvement in the engineering components or final products in which they are used. They are also the latest in revolutionary materials and the latest improvement in more traditional advanced materials.

As a designer of “hardware,” you may be tempted to assume that the best material for your use is the one you have been using. If so, you will find that this book includes many common materials of construction that have seen recent improvements. For the more adventurous, we include revolutionary materials whose use may result in great benefit, enabling unique and cost-effective product design.

This handbook presents the most recently introduced advanced materials in an effort to inform you as soon as possible of materials that may improve your product or process. Each chapter describes material characteristics from which materials can be tentatively selected for further exploration. Additional information is available from the references, engineering societies, and trade associations. Examples include The Composite Fabricators Association, The United States Advanced Ceramic Association, ASM International, The American Society of Mechanical Engineers, The Aluminum Association, The American Iron & Steel Institute, The Steel Manufacturers Association, International Titanium Association, and others. All are available through their websites.

This book’s purpose is not to provide all the data you need to select materials. Each chapter describes an individual class of materials. Most include corrosion-resistant data plus a separate chapter on this important property. The book’s purpose is to narrow your material selection. For your final decision, work with
the material supplier as a partner, sharing your problem’s parameters. Material suppliers have broad experience that will benefit your material selection. Treat them as a joint problem solver rather than a vendor. Be open to a design change that will realize the benefits of using a new material. Always test materials before use.

Some of the materials presented have revolutionary performance compared to the existing materials that you are using. Others are improvements over existing materials, but, unlike revolutionary materials, they are more familiar, with abundant engineering data, and some similarity to your existing material. Revolutionary materials, like continuous fiber ceramic composites (CFCCs), offer a breakthrough in performance in extreme environments like superior resistance to high temperature, corrosion, and wear. Others, including CFCCs, are also stronger and lighter weight.

Some of the materials presented are high priced, reflecting their high performance. They are used where the result economically benefits the provider and the user. Life-cycle costing will reveal if this is true for your application.

Designing a product involves selecting a material, shape, and manufacturing process. Finding an optimal combination of these to maximize performance and minimize cost is essential for innovation in engineering design and education.

Psychologists tell us that 5% of designers are willing to try something new and 80% will follow if the 5% are successful. Be one of the 5%. The use of new materials can save money, reduce downtime, reduce maintenance, increase operating temperature, increase efficiency, lower emissions, and reduce life-cycle costs.

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