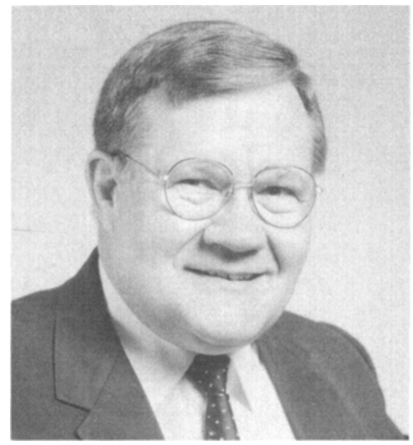
Editorial

Smart Materials



Materials are always entering into the lexicon of language in one way or another. All of us have heard of the "stone age," the "bronze age," and the "iron age." Now in some quarters, we have the "information age," which depends on the properties of the optical-electrical materials used in the advanced information/data systems.

The latest "age" that has come across my desk is the "intelligent materials age." We are now in the age of smart materials, and the possibilities are really mind boggling. Just what exactly are these new smart materials?

You have heard about or seen one of the most common in the form of sunglasses that automatically darken in the bright sunlight and become clearer in the shade or indoors. But how do you define these new materials?

Professor Craig Rogers of Virginia Polytechnic Institute and State University has an upcoming book in which he looks at smart materials from two different aspects, or as the good professor likes to say, two different paradigms. The first is based on a "technology paradigm." A smart material system is "the integration of actuators, sensors with a materials component." This definition tells you that some actuators and sensors and materials are needed, but for what? Where do you go from here? Another paradigm is the "science paradigm," which defines smart materials systems "as material systems with intelligence and life features integrated in the microstructure of the material system to reduce mass and energy and to produce adaptive functionality."

Wow! This definition does not even need actuators or sensors but, rather, defines a philosophy of design....a philosophy that seems to border on the essence of biological systems. Now that kind of design philosophy really gives us a challenge of first magnitude. Biological systems are indeed unique in the fact that they are adaptive to different environments and have the ability to perform self-repair......and to reproduce!

Biological materials systems have also had millennia to develop. Very few of us in the practical field have that luxury. But read on.

A commonly mentioned example is the human arm. Materials that behave much as muscles during contraction are called induced strain actuators and work on the idea that if energy is applied from the outside to the actuators, they attempt to contract and do work against any load that is in contact with them.

One exciting area of near-term application is in vibration control, or in that special case of vibration control we call noise control. We can have a sensor detect the presence of noise and send this information to some actuator, which will cause the source of the annoying noise to vibrate in the same vibrational spectrum but 180 degrees out of phase with the original source. That should quiet down the noise source.

Another exciting area of application is the repair of the Hubble telescope using electro-active ceramic materials to adaptively change the shape of the mirror surface until the image of a star is the very sharpest. Of course, those of us who spent years in front of one of the old scanning electron microscopes know that we were acting like smart structures when we were adjusting the fine focus to obtain the sharpest possible image on the microscope screen. Nowadays, that operation is done automatically by a smart system.

We are excited about the thought of extending the tasks we tried to perform manually (and very slowly) to the automatic "smart stage." In doing so, the design engineers will find time and time again as they try to develop the "smart" systems that the performance of their "smart" systems will be limited by the properties of the materials on their systems. After all, that is where we come into the picture, isn't it?

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