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GUEST EDITOR'S INTRODUCTION

Our materials theme, begun two issues ago, concludes with this issue of the *Digest*. As before, the articles range from basic research to applications. Research provides a fundamental understanding of material properties, and includes the making of new materials and the development of methods for material characterization. Such activities provide the foundation for improved structures, devices, and systems for advanced applications. More information on materials work at APL can be found in the introduction to the previous materials issue.[1]

We begin our continuing theme with three articles on the characterization of optical properties. Duncan et al. determine the scatter properties of several recently developed optical ceramics. Measurements are made of total volume-integrated scatter, as well as forward- and back-scatter components and spatial distribution of scatter (scatter phase function). Scatter characteristics are determined at several wavelengths. Results are used to assess the effect of scatter on optical system performance in terms of the point spread function and the modulation transfer function of the scatter. One interesting result is the unique optical effect caused by grain size uniformity of one of the materials (ALON).

Lange and Duncan measure the temperature change of the refractive index for these same materials over the temperature range from ambient to 500°C. Measurements of optical path-length growth are made in a vacuum using a Michelson interferometer. Known thermal expansion coefficients are used to remove the expansion contribution from the optical path length and derive the change in refractive index. These measurements, the scatter characterization, and the previously reported high-temperature emissivity measurements[2] are part of an assessment of new optical window materials for high-speed flight. Many of the materials were also made into windows and were aerothermally tested at APL.[3]

Development of polycrystalline diamond as an optical material has recently achieved remarkable success. Thomas and I discuss recent progress in artificial diamond preparation and survey the properties of natural type IIa diamond as a basis of comparison with man-made polycrystalline diamonds. We show recent optical property measurements made at APL, especially the temperature dependence of infrared absorption, as well as the results of attempts to model infrared absorption.

Newman introduces the subject of very high temperature materials appropriate for ramjet engine combustion chambers. Suitable materials must be stable in an oxidizing environment at temperatures as high as 2500 to 3000 K for periods of five minutes or more. He describes a test apparatus capable of rapidly evaluating samples in a realistic combustion environment and surveys several candidate high-temperature materials, composites, and material structures. Test results are summarized.

Bargeron et al. continue the topic of very high temperature materials with a study of the oxidation characteristics of hafnium diboride and hafnium carbide films. They pay particular attention to carefully prepared films without pores or cracks that would enhance oxygen diffusion into the bulk material. Oxygen diffusion into hafnium diboride and hafnium carbide produces quite different effects in each compound. The diboride forms gaseous products at the surface, which create voids that enhance oxidation. Hafnium carbide, on the other hand, forms a stable oxide outer layer and an intermediate (transitional) layer. The intermediate layer retards oxygen diffusion and provides a good match between the oxide and carbide layers, reducing oxidation and enhancing structural integrity.

Sova et al. investigate the properties of detectors made from high-temperature superconducting thin films. Two kinds of detectors are made: bolometers and nonbolometers. Desirable characteristics for these two types of detectors are quite different. The primary application for the bolometer is as an infrared detector, whereas the nonbolometric device is a better microwave detector. Both kinds of devices, made from various films, are extensively characterized and show promise as practical devices. More information on APL's high-temperature superconducting materials research and device development can be found in previous *Digest* articles.[4,5]

Charles concludes our theme with a survey of materials used in special-purpose electronics packaging. Packaging includes the materials for substrates, adhesives, etching, and encapsulation and the techniques for metallization, interconnects, package structures, and assembly. Properties of packaging materials are critical in achieving appropriate electrical properties, as well as heat dissipation, reliability, and long-term stability, especially in advanced high-speed, high-density devices. New materials and techniques are continually being developed to meet evolving needs and to improve performance. The reader is also referred to the previous materials issue of the *Digest* for articles on epoxies for hybrid microelectronics[6] and the reliability of gallium arsenide devices.[7]

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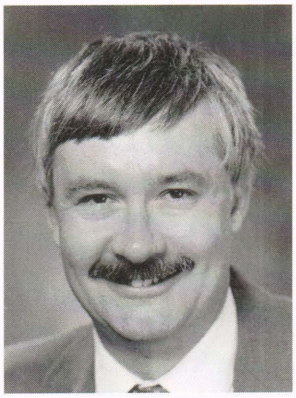

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