Guest Editorial

Optics in adverse environments

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With a steady growth in technology, we are confronted increasingly with adverse environments for both human and human-made systems. Such challenges can be met in two ways: 1) the environment can be changed or controlled so that it becomes or remains conducive to the proper functioning of the system, or 2) the system can be designed and built to withstand the hostile influences. In the case of the human system, design changes within a reasonable time frame are not possible; consequently, its proper functioning is dependent on the creation and maintenance of a suitable environment (e.g. the space suit). But for the human-made system, it is mostly the opposite. To a large extent, it would not be possible to achieve the technological advances (e.g. laser fusion) we now seek without the creation of systems which function properly in the midst of hostile environments. In certain cases, both alternatives are available, but the creation of a fully benign environment would not be cost effective (e.g. spaceborne fiber optic waveguide communication system).

This issue covers work intended to overcome the obstacles of an adverse environment for optical elements employed in the fields of power generation, communication, and detection. Primarily, these efforts impact design techniques and lead to a selection of materials and fabrication processes. In general, the papers show continuing progress in understanding the relationship between the environment and component behavior. At the same time, there remains much to do.

The requirements for an intense laser beam together with a well-corrected optical wavefront are addressed in two papers coming out of major laser fusion programs. G. R. Wirtenson presents optical surface damage threshold values for components in the ARGUS and SHIVA laser fusion systems ($\lambda = 1.06\ \mu m$) in operation at the Lawrence Livermore Laboratory, and discusses developments for improvement. In a similar vein, but dealing with different materials and working in the infrared region, B. Newnam and D. Gill at the Los Alamos Scientific Laboratories evaluate damage threshold levels of components in the HELIOS system, which uses a CO_2 laser.

Special attention is given to laser damage resistant antireflection coatings from KCl substrates used in high energy laser applications in a paper by W. T. Boord, H. Mar, and M. Ohmer. A new design with low absorption characteristics is described.

The advent of space and the generation of nuclear radiation gives rise to a pervasively adverse environment. Effects from such an environment are treated in three presentations. E. J. Friebele, in a comprehensive paper, covers the effect of nuclear radiation on fiber optic waveguides, relating the effects of radiation types and levels with different materials. In the same area, but from a more general perspective, R. Webb, L. Isaacson, and E. Marrom discuss the various activities in the field and pinpoint some significant results. J. Holzer and B. Passenheim, presenting data on the effect of nuclear radiation on the performance of laser systems used for ranging and optical communications, conclude that with nuclear-hardening techniques, both direct and coherent detection systems can function in near earth orbits and on planetary missions.

In high energy laser systems, absorption gives rise to sharp thermal gradients, which in turn introduce optical distortions. C. Klein presents a mathematical method for analyzing its effect on optical performance.

Increasing the practicality of alkali halide materials is addressed in a paper by R. Anderson, R. Skogman, and H. Vora. These materials are attractive from an optical standpoint, particularly in the infrared region, but are questionable for many applications subject to a severe mechanical environment. The mechanical properties are shown to be vastly improved for LiF and CaF_2 (and projected similarly for alkali halides in general) by press forging the materials from single crystals.

Sensor windows carried on high velocity vehicles, such as aircraft and missiles, are impacted by rain and solid particles. The resulting damage incurred degrades the transmittance. W. Adler discusses the erosion of such windows and calls for further data on transmittance loss as a function of exposure time in a well-characterized erosive environment.

Cryogenic temperature for space sensors and infrared detectors constitutes an adverse environment which affects the optical characteristics (e.g. refractive index, transmittance, and reflectance) of optical components. J. Pipes, F. Sherrell, B. Wood, and W. Clark discuss the effect of temperature and contamination on optical components working in a cryogenic space simulator and infrared calibration chamber.

The impact of adverse environments on human-made systems has particular relevance to the optical engineer in present-day technology. This issue serves well the purpose of clarifying the problems for him and pointing to solutions. We thank the authors for their excellent contributions toward this objective.