Optical Materials for Optical Systems

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I agreed to be the guest editor of this special section with mixed feelings because I am only interested in optical materials from the designer's point of view. I think that problems of materials science, which deals with properties of materials and how these properties are determined by a material's composition and structure, are less substantial for readers of *Optical Engineering*. However, I carried out many discussions with potential contributors to focus the papers' themes for this special section on practical and technical problems that are useful for engineers, and I hope I have succeeded in doing so.

Until now, knowledge of optical materials from different periods of time has been dispersed in a lot of leaflets, papers, catalogs, treatises, and books edited by researchers and producers. Optical glasses, especially for the visual spectral region given by manufacturers in their catalogs, are the most described optical materials. Information in these catalogs is constantly updated. Infrared materials are also described very broadly by such authors as P. Billard, J. A. Savage, W. L. Wolfe, P. Klocek, and a few others.

Optical systems contain different types of optical materials such as reflective, refractive, holographic, and nonlinear optical elements for different spectral regions (infrared, visual, and ultraviolet). Optical materials may have different chemical natures (optical glasses, crystals, plastics, metals, and even liquids). In any case we may not limit the materials' properties to only optical ones. Mechanical, thermal, chemical, electrical, magnetic, and acousto-optical properties play important roles in modern optical devices. In fact, knowledge of optical materials is huge, estimated up to a few thousand publications, but our knowledge is far from perfect.

New information on optical materials is never unwelcome. One of the most important tasks of the optical designer is proper selection of optical materials together with full geometry. For simple optical systems, which demonstrate low requirements and are placed in a standard environment, the selection of the optical materials is not critical, as we know from practice. Such optical systems may be solved by many combinations of the optical materials. For modern optical systems, which demonstrate high performance and are placed in an aggressive environment (temperature and/or pressure), selection of the optical materials is far more complicated. On the other hand, certain optical elements must realize extra physical functions (birefringence, polarization, diffusion). In such and similar cases the selection of optical materials appears very sophisticated and is not free from compromise.

I have made efforts to make the special section as representative as possible. I requested participation from seven Russian, ten American, and three Japanese authors, in addition to a few others. I have attracted the highest number of contributors from my geographic region only due to my personal initiative. There may be different reasons for this situation. Information in the special section may not be stimulating for regular authors and thus I specially contacted some selected authors to write papers for the section. I am convinced that many achievements in the field cannot be published because of technical secrets. Moreover, several scientific information papers were intended for a few conferences being organized at the time. Finally, the proportion between the Polish authors and contributors from other countries is as high as 8 to 5.

Areas in the field covered by this special section include thermal effects, GRIN materials and their applications, glasses for fiber optics, image guide rods, planar waveguides, interferometry, and nonlinear materials.

The paper written by Klein deals with some materials for high-energy laser systems cooled during work. Very interesting practical remarks on the mirror and window material assessments are included. This paper is a revised version of an earlier publication included in the excellent book *Inorganic Optical Materials* [Paul Klocek, Ed., **CR64**, 3203–3226, SPIE Optical Engineering Press, Bellingham, WA (1996)].

Different thermal effects and their reduction by means of optical and mechanical materials are discussed in the paper by Kryszczynski and Lesniewski. Thermal coefficients originally introduced by us may be very helpful for selection of materials and athermalization of optical systems in the optimization process.

The next paper by Wawrzyniuk and Dymny deals with their method of thermographic and interferometric measurements of subtle surface changes under variable thermal conditions. The materials problem was limited to BK7 glass and fused silica from which plane parallel plates were made.

There is opportunity to have access to more extended technical information on GRIN materials, which are not standardized so far. The important paper by Manhart and Blankenbecler gives better opportunity than many others because they have gathered their own rich experiences over the past several years.

Wychowaniec reports on the phosphate-silver-alumina glass used to make gradient index rods of diameters up to 8 mm. This is a revised version of the paper found in *Gradient-Index Optics in Science and Engineering, Proc. SPIE* **2943**, 69–77, M. Pluta, Ed. (1996).

Opilski et al. have described the technological process with an exemplary application to produce waveguide structures in glass using the ion exchange technique.

Kociszewski, Stępień, and Pysz discuss material problems for image guide rods. Special glasses with added oxides are researched. Their result is a good example of the bridge between material science and optical engineering.

The next two papers report a number of experimental studies of structural, chemical, physical, and optical properties of various glasses. Wasylak, Łączka, and Kucharski describe the results of performed investigations of halide-chalcogenide glasses, which represent a suitable material for optical fiber technique applications. Wasylak presents investigation results for new kinds of amorphous glassy materials. It is worthwhile to turn our attention to the possibilities of the application of glasses transmitting infrared radiation. Samek and Wasylak have developed a fluorozirconate glass that is very important for interference interferometry of a water-like medium.

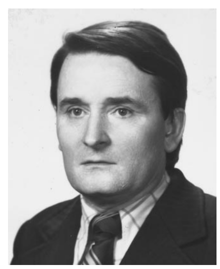
Mochalov's paper covers laser and nonlinear properties of potassium gadolinium, one of the most efficient laser crystals. He shares with us the practical experiences and theoretical considerations that led to important conclusions on how to control actively the spectral, temporal, spatial, and energetic characteristics of new generations of laser systems.

Bubnov et al. describe a laser device for examining nonlinear photoinduced processes and damage under high-power laser radiation in the near-IR spectral range. On the other hand, Berezhnoy reports an electro-optical and photorefractive device using ferroelectrical crystals as spatial modulators.

The scope of these papers shows that this special section covers many important aspects of a wide topic area. It is important to note the practical approach in the majority of the papers, even in those representing material sciences. Our special section does not make any claims to deal exhaustively with the broad subject of optical materials. I hope that it will prove to be helpful for many optical designers.

This special section is a forum to exchange experiences between the East and West on optical materials problems that have been independently developed during recent years. Such a presentation can be fruitful and creative.

I would like to take this opportunity to thank all the authors for taking part in this special section and Prof. Maksymilian Pluta for his encouragement and help during the reviewing process. I also offer my thanks to Prof. Brian J. Thompson and his *Optical Engineering* staff, especially Karolyn Labes, for their patience, indulgence, and help with the editorial process and for publishing this combination of papers on optical materials for optical systems.



Tadeusz Kryszczynski received his MSc and PhD degrees from the Warsaw University of Technology, Department of Precision Mechanics, in 1961 and 1971, respectively. He has been affiliated with the Institute of Applied Optics, Warsaw, heading the Geometrical Optics Department. His main research interests are the different problems of zoom systems, optical methods for automatic design, microscope optics, laser optics, IR optical systems, and others. He is the author of the professional microcomputer system for optical design. He has authored or coauthored 80 scientific/technical papers and 15 patents on optical themes. Moreover, he has developed about 50 significant optical devices, many of which were (or still are) manufactured. He was named the 1996 recipient of SPIE's A. E. Conrady Award.