Information Optics Using Polymeric Materials

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We are now entering into an information age powered by rapidly evolving technologies in areas of microelectronics, computing and communications. Optics plays some crucial and complementing roles to electronics in many application domains. Examples of successful use of optics can be found in broadband communications, high-capacity information storage, and large screen and portable information display. As demands for information bandwidth increase, information optics is becoming more and more important in every aspect of today's technology-driven society. The success of a new technology, however, largely depends on the progress achieved in finding and fabricating new cost-effective materials.

Early developments of synthetic materials, such as polymer materials were mainly for applications other than optics. In areas of information technology, polymer materials were first used for their insulating and dielectric properties. Recently, as the knowledge base of polymer materials widened, new functions for polymers have been actively investigated. New and improved polymer materials were found to show promises in generating, processing, transmitting, detecting, and storing light signals. Breakthroughs have been reported in areas of electro-optic polymers with electro-optic activities larger than some well-known and widely used crystals, and in areas of graded-index polymer fibers which maintained large bandwidth capability while relaxing critical connector alignment tolerance. Injection-molded polymer optical components nowadays can outperform traditional glass-based counterparts in many mass market imaging applications. These new developments gradually cleared misconceptions about polymers being inherently fragile and unstable.

Developments of polymer materials and their information optics applications involve diversified and multidisciplinary efforts engaging chemists, physicists, optical scientists and engineers. To further fuel the growth of this active and dynamic area, we gathered together 14 scientific and engineering papers in this special section dedicated to Information Optics Using Polymeric Materials. These papers can give our readers a glance of the diversity of the field from light emission, modulation, and switching to information storage and display, and from new material synthesis and characterization to fabrication. The objectives of these studies are to enhance optical integrated circuits, to improve communication and interconnect switching, to deliver substrate quality and stability of optical storage disks, to increase brightness and light efficiency of projection display, and to extend the range and capability of target detection using phase array radar, to name but a few.

The 14 papers are organized in clusters to help the flow of presentation of the special section. The first group contains three papers, mainly addressing material development issues. The first paper, by Dalton, discusses methods to improve electro-optic activity at the same time as to reduce optical loss and fine-tune other performance characteristics. The second paper, by Eldada et al., addresses various issues on how to improve polymer optical waveguides so that these materials can meet application demands on flexibility, toughness, loss, and environmental stability. The paper also reviews various implementable passive and active polymer optical components. The last paper in the group, by Lafond et al., reports their investigation of the photochemical process of dichromated gelatin as optical recording material in an effort to provide a better understanding of its recording mechanism.

The next cluster has four papers, primarily in areas of investigating nonlinear optical effects of polymer materials. Sarkisov et al. investigate doped PMMA film for its dark spatial soliton generation possibility, propose a theoretical model for such phenomena and discuss applications of these solitons for optical interconnections. Xiong et al. report their finding of nonlinear optical switching in specially designed twin-core polymer optical fibers and its suitability for future all-optical switching for data communication. Li and Bao examine the nonlinear fourwave mixing in azo-dye-doped polymer films for nonresonant holographic storage applications. The last paper in the group, by Cohen and Mears, discusses a nonlinear optical polymer-based micro-Fabry-Perot and its possible usage for future spatial light modulators.

The third cluster consists of four papers related to electro-optic effects of photopolymers and their applications. Tang et al. first present a domain-inverted electro-optic polymer as a possible backbone material to build a highly efficient linear waveguide modulator for various photonic switching applications. Seoul and Song show their study results on DO-PPP based polymer lightemitting devices. Kikuchi et al. report their design, fabrication, and testing efforts for a polarizer-free, polymerdispersed liquid-crystal-based projection display which exhibits a contrast as high as 80:1 and brightness greater than 1,800 lumens. Last but not the least, Yin et al. report their measurements of electro-optic coefficient in a PVDF related material.

The last cluster contains three papers that can be described as other optical devices using polymer materials. Moisel et al. present an integrated polymer optical waveguide-based computer back-plane interconnect. Multimode low loss polymer waveguides are formed and integrated on boards with other coupling components. A ring network and a 4×4 star network using the integrated polymer circuits is demonstrated. Tang et al. disclose a new optical true-time delay device using a low loss polymer waveguide. Such a true-time delay is often needed for wide-band phased array antenna. The demonstrated technology allows hybrid integration and packaging of optical components with micro-wave components. Finally, the last paper of the cluster and also of the entire special section, by Kang et al., discusses their effort to improve manufacturability of optical disks formed by injection compression molding of polymers. The focus of the study is on birefringence measurement, characterization and control of the polycarbonate magneto-optic disk substrates.

Polymer materials will continue to play various important roles in future information optics. The present collection of papers will serve not only as a status report of some recent research and development activities, but also as a stepping stone to spur future growth and interest in these and other related technologies. Hopefully, some of the interesting concepts, ideas and results presented here can lead scientists and engineers alike to various new directions in this exciting field. Finally, I would like to take this opportunity to thank all contributors for choosing this forum to present their interesting results, and all reviewers who helped with the quality control aspect of these publications. A special thanks goes to my secretary, Mary Anne Rich, who pitched in countless hours for the not so fun part, i.e. to help me with record keeping and following up with authors and reviewers. Last, but not the least, my sincere appreciation is extended to the *Optical Engineering* staff for their guidance and support.

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