Guest Editorial

Acousto-Optics

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Acousto-optic component technology and instrumentation continue to mature, and interest in practical applications has accelerated during the past year. Following our symposium in San Diego in August 1976 and publication of the Proceedings (SPIE Volume 90), it was decided to review recent progress and to report in a special issue of *Optical Engineering* the current state-of-the-art. Thus, this edition of the journal features a series of nine articles dealing with the theory and reduction-to-practice aspects of acoustic imaging and holography, bulk wave and surface wave devices, and other systems such as optical correlators and integrated optical radio frequency spectrum analyzers.

Applications of vision by ultrasound have been found in medical diagnosis, acoustic microscopy, non-destructive testing, oceanic search and seismic sensing. Significant progress has been made in the last two years towards understanding the tradeoffs and limitations of specific approaches. Image quality continues to improve as processing techniques and hardware are better understood. Opto-acoustic transducer device development offers the possibility of real-time imaging in a manner similar to that of a scanning electron-beam microscope.

Advances in materials research and design technique are supporting systems utilizing a variety of electro-optical, semiconductor and microwave hardware. Design technique, material developments and fabrication technology have all progressed to the point that quite a variety of acousto-optic devices can be produced with impressive processing capabilities. We now find that in order to get these devices out of the one-of-a-kind research lab and into field application we must solve the next class of material and design problems. In the case of surface wave devices, these problems have to do with thermal stability, material aging, and other factors which are in the less than 1% category in terms of effect on wave propagation parameters. For devices with processing gains on the order of 100, most of these effects are pretty well controllable. When one goes to the 1,000 to 10,000 range, which is now possible, there still remains a good deal of careful work to be done in both the material and processing area. In the area of optical interaction with acoustic surface waves, it seems that the acoustic devices are capable of producing very attractive parameters but the thin film optical components required for integrated processors are lacking. In particular, a large area optical wave guide with suitable coupling and uniformity of characteristics is still missing.

In terms of applications for bulk wave devices such as deflectors, modulators and tunable acousto-optic filters, the prospect of improved materials and transducer performance is good. For materials, there is an emperical tradeoff relation between figure of merit and acoustic attenuation. This relation appears to set an ultimate limit on the achievable performance of these devices. There seems to be no fundamental limit on the potential improvement in transducer performance, however. Transducers with a conversion loss of a few dB and an octave bandwidth operating at several GHz are expected to be available in the near future.

As a result of recent progress on transducer technology, GHz bandwidth deflectors have been demonstrated. Based on the progress in acousto-optic materials, filters operating from the UV to the middle infrared have been fabricated. Modulators, on the other hand, are in a stage of design evolution with little work going on with new materials or techniques. Some available materials such as rutile and diamond still have not been thoroughly evaluated for practical device applications. At present, wideband modulators represent a relatively small market and even that is being diminished to some extent by the development of directly modulatable sources such as the semiconductor laser.

Finally, other types of signal processing systems which use acousto-optic devices are beginning to move out of the laboratory and into the field. These systems are augmenting conventional equipment while offering the advantages of reduced size, weight and cost.

The editors would like to take this opportunity to express our appreciation to the twenty authors who contributed to this special issue on acousto-optics. We recognize the need to communicate ideas and results in this rapidly expanding technology and welcome reader comments.