The frequency-shifted feedback (FSF) laser has shown to be a novel light source in the optical frequency domain reflectometry (OFDR) technique, and has been widely utilized in the measurements of hydraulic pressure, atmospheric temperature, and fiber dispersion. The FSF laser operation is achieved by feedback of the first-order diffracted light of an intracavity acoustooptic frequency shifter (AOFS). For its applications, a compact and stable FSF fiber laser is required. However, there is a difficulty in realizing the integration and stabilization of the present bulk-type AOFS because a bulk acoustic wave and spatial lights are used. In this paper, a waveguide-type AOFS driven by a surface acoustic wave (SAW) in a tapered crossed-channel proton-exchanged (PE) optical waveguide on a 128°-rotated Y-cut LiNbO₃ substrate is demonstrated at an optical wavelength of 1.55 µm, and FSF laser oscillation is realized with this AOFS. The channel optical waveguide was fabricated by first forming an rf-sputtered Ta₂O₅ mask (with a film thickness of 0.08 µm) on the substrate and then by carrying out the PE process and postannealing for a defined time. The fabrication conditions of the waveguide were designed to achieve a higher coupling efficiency for an optical fiber. As a result, the conditions used were as follows: a PE time of 1 h 15 min in a solution of benzoic acid containing 0.2 mole % lithium benzoate at 240°C, an annealing time of 1 h 40 min at 400°C, and a waveguide width of 10 mm. A Gaussian index profile with a change in extraordinary refractive index ($\Delta n_e$) of 0.021 and a waveguide depth of 4.1 µm at $\Delta n_e/e$ was obtained. The waveguide shape in the acoustooptic interaction region was designed to make the interaction region longer and thus the driving SAW power lower. After forming an interdigital transducer with a period length of 20 µm and an overlap length of 2 mm, the AOFS was incorporated into a module and connected to the input and output fibers optically. A 35% diffraction efficiency and 10% throughput were obtained at an input voltage of 10 V$_{rms}$. Furthermore, the FSF laser oscillation with the module was obtained and an oscillation
spectral width of 0.62 nm and a beat frequency spectral width of 12 kHz were demonstrated.

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P2O-2

**LIGHT-SCATTERING STUDIES OF ACOUSTICAL ACTIVITY AND ATTENUATION IN LINBO3 AND LITAO3 CRYSTALS**

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Bragg light scattering method for simultaneous studying of acoustical activity and of attenuation of hypersonic waves was applied to LiNbO3 and LiTaO3 ferro-electrics. The examined samples of LiNbO3 and LiTaO3 were cut from optically clear single crystals and oriented along the crystallographic axis of the third order with the accuracy of 10°. Piezoelectric transducers of Lithium Niobate of appropriate cuts are used in order to excite the plane-polarized transverse acoustic waves in the frequency range from 400 MHz to 1.8 GHz. Measurements of the dependence of the scattered light intensity from the distance to the piezoelectric transducer along the direction of the acoustic wave propagation have been carried out in automatic regime by using the computer, which worked under the control of the special program. The scattered light intensity can be presented as function dependence of the light intensity with respect to distance of acoustic wave shift. The obtained values of the scattered light intensities have been used to calculate the quantity and frequency dependence of the attenuation and of the specific rotation of polarization vector in given acoustic wave by modeling of above-mentioned equation. The effective constants of acoustical activity along the investigated direction were determined from the experimental data simultaneously. There has been shown the high efficiency and trustworthiness of the results of simultaneous calculation of attenuation coefficient and specific rotation of the polarization plane in gyrotropic crystals, as well as possibility of speculation of experimental curves by varying factors, which are changed in a real experiment. The attenuation of acoustic waves in the bulk of LiTaO3 has been determined for various modes and propagation directions, allowing the complete determination of the viscosity tensor, from which the attenuation coefficient can be calculated for any desired type of acoustic wave in LiTaO3.

P2O-3

**ALL-OPTICAL ACOUSTO-OPTIC INTERACTION IN TELLURIUM DIOXIDE CRYSTAL**

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An experimental investigation into the all-optical acousto-optic interaction within a tellurium dioxide crystal is presented. The all-optical acousto-optic effect describes the combination of laser generated ultrasound with acousto-optic interaction. Laser generated ultrasound spectra are analyzed for tellurium dioxide using a 266 nm and a 1064 nm pulsed source, and used to characterize the acousto-optic interaction. The interaction is shown to be dominated by longitudinal acoustic waves. Results are given for a simple device structure which obtains nearly a thirty percent diffraction efficiency. Future trends are also discussed.

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TUESDAY, OCTOBER 7, 2003

* Author presenting Paper

Session: 1G

CONTRAST AGENTS IV
Chair: H. Routh
Philips Research

1G-1 4:30 p.m.
(Invited)
ULTRASOUND-INDUCED BIOEFFECTS:
MICROBUBBLES AND PATHOPHYSIOLOGIC
RESPONSES TO INJURY

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Although the benefits of ultrasound contrast agents (CA) are widely accepted, researchers are assessing their cardiovascular risks. CA-induced cardiovascular bioeffect risks can be categorized as: intravascular, transvascular, and extravascular. Intravascular bioeffects are characterized by hemolysis of erythrocytes in microbubble-containing insonified blood. Results of in vivo studies, supported by in vitro studies, document this phenomenon. Cavitation is the suggested mechanism. Transvascular bioeffects are characterized by injury to capillaries, arterioles, or venules. Results of in vivo studies have documented: 1) vascular leakage; 2) hemorrhage; and 3) leukocyte adhesion following insonification of microbubbles in blood. Based on vascular structure, the mechanism of injury is likely limited to capillaries. Results of in vivo studies suggest that leakage could result from alterations in endothelial permeability and alterations of occluding (tight) and anchoring junctions of continuous and fenestrated endothelia (skin, muscle, intestine). Mechanisms leading to hemorrhage require endothelial injury of sufficient severity to allow erythrocytes to escape. It has been hypothesized that leakage and hemorrhage result from cavitation. Injury to endothelia could also result in alterations of membrane: 1) selectins, ICAMs, and integrins that mediate leukocyte/platelet-endothelial cell adhesion, and 2) proteins that