across all channels, from a single input, has been demonstrated. These results are promising for power distribution in photonic network applications or on-chip sensors. The sensitivities of the fabricated LPGs to temperature and to the refractive index of the surrounding medium have been investigated and are discussed.

7598-25, Session 6

Time evolution of an electro-optic modulator by detection of its nonlinear behavior

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Optoelectronic oscillators use electro-optic modulators for converting the microwave signal into optical modulated signal. These oscillators must present a very low phase noise and a very time stable oscillation frequency. Stabilization of the different elements is absolutely required and especially for the modulator. By using a digital system for controlling both temperature and optical bias point it is possible to improve the time evolution of the oscillator and to reduce the phase noise. This system can also be used as a complete instrumentation tool for analyzing the behavior of the modulator. By using the system as an open loop the evolution of the modulator can be monitored. The technique is based on non-linearity measurement. A low frequency is applied to the modulator and the phase of second harmonic component is determined in order to know the evolution of the real optical bias point on the transfer function of the modulator. The drift of the modulator is observed according to different experimental conditions. Different temperature changes have been applied by small steps and the corresponding non linearity has been recorded. Temperature and optical bias point drift are clearly correlated. By controlling the temperature it can be shown that the drift of the optical bias point is significantly reduced. But hysteresis effects are underlined, proving that other physical effects lead to the drift of the modulator bias point. This technique has been applied to modulators made of lithium-niobate material but are also currently used for analyzing electro-optic polymer based modulators.

7598-26, Session 6

Ultra-narrowband notch filter for Raman applications

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We report on an angularly tunable notch filter from 760 nm to 785 nm with an OD of 5.5, more than 80% transmission and narrow 3dB bandwidth of 9 cm-1 (0.55 nm). The notch filter is a single element composed of six bonded slanted reflective volume holographic gratings in glass.

Notch filters are an essential component in Raman instruments. They greatly attenuate the backscattered light from the laser illuminating the sample, while letting the faint spectrally shifted Raman signature pass through. Two non-dispersive filter technologies are currently used for wavelength blockers: holographic (with dichromate gelatin) and thin film. Both are limited to 3dB rejection bandwidth of approximately 400 cm-1 or greater.

The Raman signal in the low frequency shift region, i.e near the frequency of the excitation laser, contains critical information about the molecular structure. For example, carbon nanotubes exhibit vibration modes in the range of 150 cm-1 to 200 cm-1 depending on their size. Relaxation in liquids, solutions and biological samples exhibit Raman shift, in the range between 0 and 400 cm-1.

We have demonstrated a non-dispersive holographic notch filter technology capable of observing the Raman signal near the excitation wavelength (10 cm-1). The novelty of the approach is the compactness of the notch filter (~ 10 mm thickness) realized by bonding individual notch filters without creating spurious multiple diffractions. Such ultra-narrow-band wavelength blockers can thus be used in standard compact Raman instruments and help bring high-end research to a greater number of users.

7598-27, Session 6

A new class of polarization filters for laser applications

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We describe a unique new, high-contrast, laser-grade polarizer which also acts a high-performance bandpass filter for the desired, transmitted polarization. This thin-film based polarizer combines a polarization contrast ratio greater than 1,000,000-to-1 (extinction ratio < 10-6) with the a bandpass filter with transmission > 93%, very steep edges, and high out-of-band blocking, all in a single, high-layer-count optical coating. Compared to other polarizer technologies, it offers superior optical quality, high angle-of-incidence tolerance, and large clear apertures making it suitable for high-performance imaging applications. And this filter exhibits excellent environmental reliability and high laser damage threshold (> 1 J/cm2).

These new polarizing bandpass filters are excellent laser source clean-up filters to eliminate the undesired polarization at the laser line and light noise away from the laser wavelength, as well as detection filters to pass a laser wavelength range and block background noise. They are ideal for a wide variety of laboratory laser applications, especially those involving holographic and interferometric systems, as well as laser materials processing, polarization diversity detection in communications and rangefinding, and fluorescence polarization and second-harmonic-generation imaging.

7598-28, Session 7

High-aperture narrowband filter based on Moiré Principle

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Uniform reflective volume Bragg grating (VBG) is common distributed feedback system with high spectral selectivity typically hundreds of picometers at optical frequencies. We propose implementation of narrow-band filter in VBG with bandwidth less than ten picometers. Two recorded Bragg gratings with the same modulation amplitudes and slightly different resonant wavelengths form moiré pattern with average carrier spatial frequency and slowly varying envelope of modulation amplitude. Each semi-period of modulation is just apodized reflective VBG; however two of them together form Fabry-Perot cavity due to phase π-shift as result of sign change of slowly varying envelope. This cavity demonstrates very narrow transmission peak at resonant frequency. Spectral properties of such filter were investigated, using our recently formulated approach based on theoretical concept of Strength of Reflection. We fabricated first moiré VBG filter in photo-thermo-refractive glass by two consecutive recording of gratings with close resonance wavelengths near 1550 nm in the same wafer. After cutting of two semi-periods, polishing and coating we got filter with aperture size 5 mm, bandwidth 50 pm and 95% maximum transmittance. Transverse degrees of freedom in VBG give tuning possibilities. Resonance wavelength is shifting quadratically with small angle of grating tilt. We discuss also cases when carrier Bragg grating wave vector does not coincide with moiré pattern wave vector. It allows creating filters with tunable bandwidths and peak profiles. Robust solid-state moiré VBG filters tolerant to high-power laser radiation with tunable filtering characteristics are suggested as optical elements for laser design and spectroscopy applications.