Crystal Technology, Inc.

An EPCOS Company

AOTF

Acousto-Optic Tunable Filters

Feature Highlights

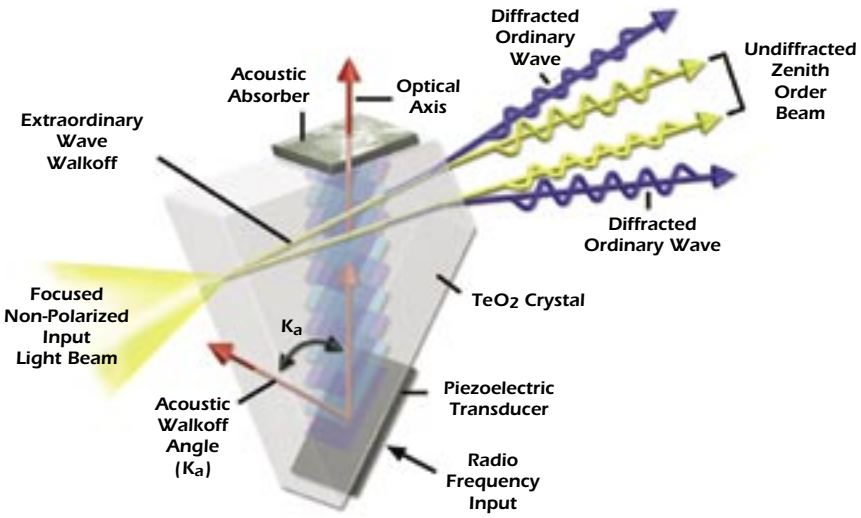
- Broad optical tuning range
- Fast electronic control
- Rapid Scanning
- Random spectral access
- High optical throughput
- High spectral resolution
- Low drive power

Acousto-Optic Tunable Filters (AOTF)

Crystal Technology, Inc. offers Acousto-Optic Tunable Filters for a variety of markets including, life sciences, spectroscopy, homeland security, telecom and others. The diversity of applications demands a wide range of AOTFs covering the spectral range of UV through NIR. From lamp illumination to lasers, each AOTF is specifically tailored for optimum performance. Novel AOTF configurations have achieved hyper spectral selectivity, very low drive power, and high diffraction efficiency. Many standard models are configured for plug and play with our microprocessor-based electronics. Enabling this feature minimizes setup, allows for closed loop control and delivers device specific infomation at a query.

In an AOTF, a piezoelectric transducer is bonded to a birefringent crystal (tellurium dioxide, lithium niobate, or quartz for example) to generate ultrasonic waves that periodically modulate the crystal's refractive index. This periodic index modulation creates a phase grating where by an incident beam transversing across at the Bragg angle splits into its appropriate diffraction orders. In this interaction the energy flow of the acoustic wave and the optical beam are practically orthogonal to each other. By varying the acoustic wave frequency, the period of the phase grating is changed and hence the wavelength of the diffracted light. In the same manner, varying the acoustic wave amplitude changes the intensity of the diffracted light. Diffraction efficiencies can reach 90% with modulation rates in the megahertz for both wavelength and intensity. A typical AOTF can accept incident light having a maximum half-cone angle of approximately 5 degrees, allowing these devices to be used in imaging and spectroscopic applications.

AOTF Anatomy and Diffraction Process



Part #	Wavelength (µm)	Polarization	RF Tuning (MHz)	Aperture h x l (mm)	Resolution (nm)	Acceptance Cone (degrees)	Diff. Eff.	RF Power (Watts)
97-01776-01	0.405 - 0.7	Linear/ Random	106 - 225	5 x 5	1.15 @ 0.4 µm 7.0 @ 0.7 µm	± 2.5	85%	0.40 - 1.2
97-02583-01	0.52 - 0.950	Linear/ Random	75 - 155	6 x 8	3.5 @ 0.52 µm 13.0 @ 0.95 µm	± 2.5	75%	1.0 - 2.0
97-02536-01	1.2 - 2.4	Linear/ Random	29 - 60	15 x 15	7.0 @ 1.20 µm 22.0 @ 2.40 µm	—	80% @ 1.2 µm 50% @ 2.4 µm	3.5 - 5.0
97-01608-01	0.7 - 1.0	Linear/ Random	125 - 190	1 x 1	0.45 @ 0.7 µm 0.1 @ 1.0 µm	± 0.5	90%	2.0
97-02405-01	1.4 - 2.45	Linear/ Random	52.5 - 95	3 x 5.5	3.5 @ 1.4 µm 10.0 @ 2.45 µm	± 3.0	80% @ 1.4 µm 45% @ 2.45 µm	3.0

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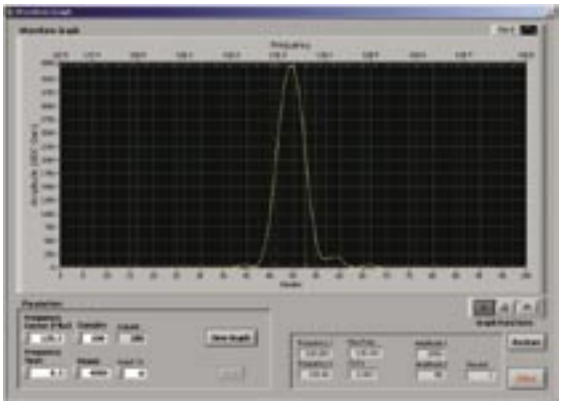


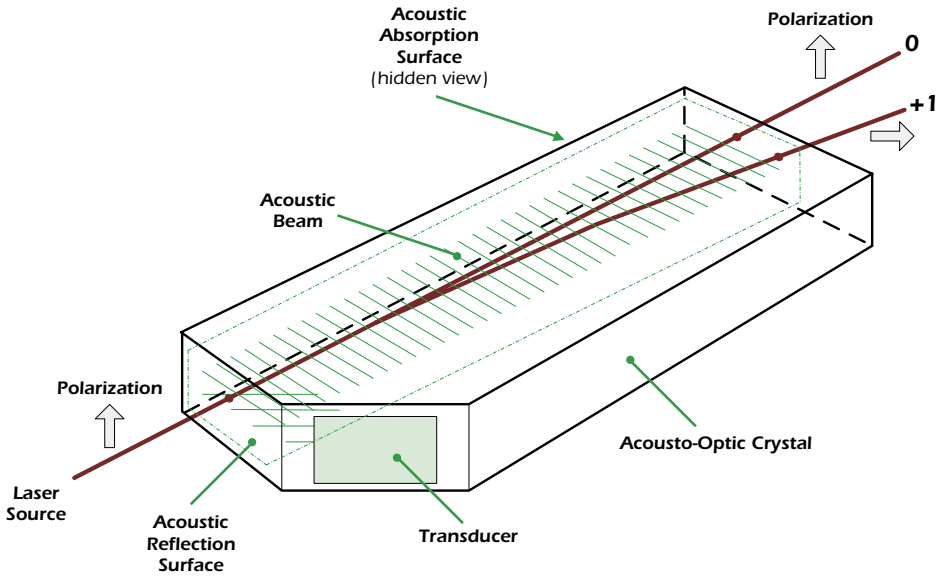
Collinear Beam AOTF (CBAOTF)

Collinear beam AOTFs have been developed to yield narrow filter functions with Angstrom spectral resolution. These devices are particularly suited for applications in spectroscopy as well as telecommunication which can benefit from their wide spectral tuning range, high resolution, negligible sidelobes and low RF power.

In the CBAOTF, the acoustic propagation and optical beam flows both follow approximately the same path along the interaction zone. This enables long interaction lengths producing very high resolution and very low drive power. This device operation is particularly sensitive to optical beam divergence and requires low divergent collimated light for optimum performance. A tell tale signature of this device is seen by its asymmetric filter function shown to the left

Crystal Technology holds numerous patents related to collinear beam devices.

CBAOTF Function Diagram



Part #	Wavelength (µm)	Polarization	RF Tuning (MHz)	Aperture h x l (mm)	Resolution (nm)	Acceptance Cone (degrees)	Diff. Eff.	RF Power (Watts)
97-02768-01	430 - 690	Linear/Vertical	60 - 115	4 x 4	< 0.60	collimated	90%	15mW
97-02703-04	1530 - 1560	Linear/Horizontal	46 - 47	3 x 3	< 0.70	collimated	90%	50mW

US PATENT
Patent Portfolio

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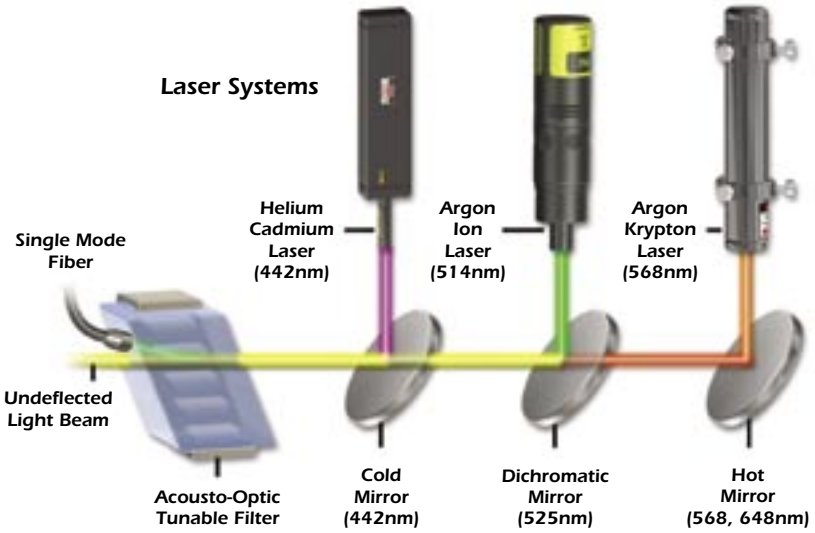
Polychromatic Acousto-Optic Modulators (PCAOM)

Polychromatic acousto-optic modulators are a special configuration of an AOTF. The relationship with acoustic wave frequency and diffraction angle causes diffraction of different wavelengths at different diffraction angles. A goal of the PCAOM is to maintain all the diffracted wavelengths collinearly on the same beam path as they exit the crystal. Consistent batch-to-batch material quality and strict manufacturing processes insure this on a routine basis. The high modulation rate of the diffracted beam also distinguishes the PCAOM. Optimizing drive power, beam collinearity, wavelength range, diffraction efficiency, and acceptance angle can yield video bandwidths of a few megahertz ideally suiting them for laser displays and other dynamic phenomena visualization.

Acousto-Optic Tunable Filters in Confocal Microscope



Part #	Wavelength (µm)	Polarization	RF Tuning (MHz)	Aperture h x l (mm)	Resolution (nm)	Acceptance Cone (degrees)	Diff. Eff.	RF Power (Watts)
97-02837-01	0.35 - 0.43	Linear/Vertical	85 - 135	2.5 x 2.5	1.0 @ 0.39 µm	± 0.1	90%	0.04
97-02769-01	0.43 - 0.65	Linear/Horizontal	80 - 150	1.8 x 1.8	2.0 @ 0.43 µm	± 0.1	90%	0.15
97-02827-01	0.45 - 0.67	Linear/Vertical	80 - 140	2.5 x 2.5	1.3 @ 0.48 µm	± 0.1	90%	0.12
97-02838-01	0.45 - 0.67	Linear/Vertical	85 - 145	2.5 x 2.5	1.3 @ 0.48 µm	± 0.1	90%	0.12
97-02885-02	0.45 - 0.67	Linear/Vertical	85 - 145	2.5 x 2.5	2.0 @ 0.48 µm	± 0.1	90%	0.20
97-02885-04	0.45 - 0.67	Linear/Vertical	85 - 145	2.5 x 2.5	4.0 @ 0.48 µm	± 0.1	90%	0.40

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