

LASER LINE TUNABLE FILTER™



The LLTF is a non-dispersive, sub-nm tunable bandpass filter that transmits a single laser line while blocking unwanted lines. It delivers the highest signal throughput in the industry. Output pointing is very stable, removing the need to realign optical setup. This filter is perfectly matched to our TTNF for Raman applications. It is also ideal as a pre-monochromator for triple spectrograph. The LLTF is compatible with any VIS-NIR broadband source. Free space of fibered, the LLTF is the only tunable filter with an isolation higher than OD4.

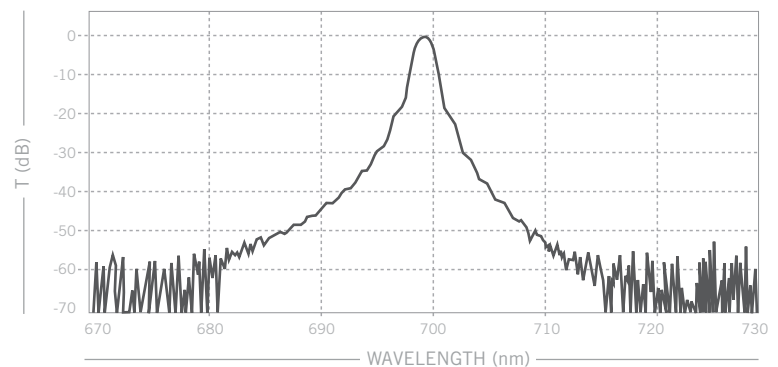
*STANDARD PRODUCTS	Spectral Range (nm)	Bandwidth (FWHM) (nm)
LLTF 850	715-1000	0.4
LLTF 950	800-1100	0.4
LLTF VIS-2	400-1000	2
LLTF SWIR	1000-2300	4

*Custom tuning ranges and bandwidths are available.

TECHNICAL SPECIFICATIONS

Pointing Stability	< 1 mm lateral displacement
Peak Transmission	up to 60 %
Grating Damage Threshold	> 100 kW/cm ² average power > 5 GW/cm ² peak power @ 1064 nm, 8 ns
Aperture Diameter	5 mm
Dimensions (L x W x H)	10" x 7.5" x 9.25" 25.4 cm x 19.1 cm x 23.5 cm
Operating Temperature	10 to 40°C
Storage Temperature	5 to 50°C
Software	PHYSpec included or ActiveX drivers
Computer Connection	USB 2.0 (compatible 1.1)
Power Supply	100 - 240 V , 50 - 60 Hz
Wavelength Relative Resolution	0.05 nm (for FWHM = 0.3 nm)

EXAMPLE OF MEASURED LINE PROFILE OF A SUPERCONTINUUM LASER PASSING THROUGH PHOTON ETC.'S LLTF



APPLICATIONS

CARBON NANOTUBE CHARACTERIZATION

Raman spectroscopy (RS) is a powerful tool to study vibrational, optical, and electronic properties of materials in a non-destructive manner. In the study of carbon nanotube (CNT) the nanostructures determine transition energies and therefore the excitation laser line should be continuously tuned to match optical transitions of the material, leading to Resonant Raman Spectroscopy (RRS), a unique tool to characterize the size distribution and chirality of a mixed population of nanotubes. RRS is also a powerful method to monitor in-situ the CNT composition during growth.

In the present setup, the Laser Line Tunable Filter (LLTF) is installed just after the excitation laser and blocks the unwanted fluorescence. Two steering mirrors (M1 and BS) send the laser line to the microscope where the laser beam is focused on the sample. The second filter, a Tunable Top Notch Filter (TTNF), is installed after the microscope and blocks the Rayleigh scattering coming from the material, leaving the Raman signal untouched down to 50 cm^{-1} with a throughput higher than 60%. After the TTNF, a standard spectrometer can be used to analyse low frequency Raman signals that would normally require the use of a triple spectrometer.

The filters are controlled by a computer via USB links. Thus, changing the wavelength of operation only takes a few minutes. Stokes and anti-Stokes Raman spectra of single-walled carbon nanotube powder presented in figure 2 were measured within less than one hour using a standard spectrometer. Each peak corresponds to a radial breathing mode and the center frequency of a given peak is inversely proportional to nanotube diameter of a given population. Several populations of nanotube with different diameters can therefore be readily observed and effectively characterized.

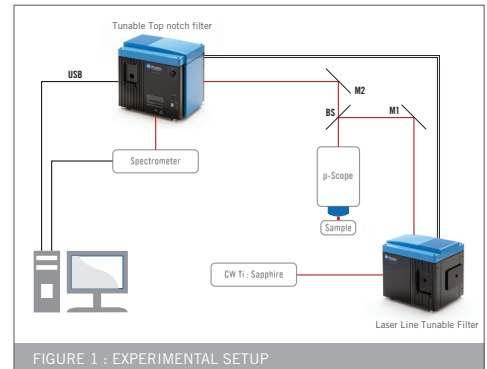


FIGURE 1 : EXPERIMENTAL SETUP

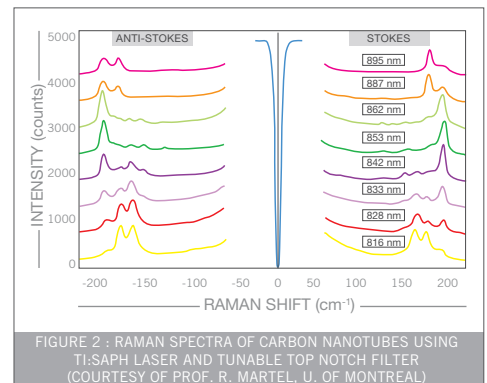


FIGURE 2 : RAMAN SPECTRA OF CARBON NANOTUBES USING Ti:SAPH LASER AND TUNABLE TOP NOTCH FILTER (COURTESY OF PROF. R. MARTEL, U. OF MONTREAL)

THIN FILM CHARACTERIZATION

Magneto-optical (MO) effects are used either for probing the magnetization reversal characteristics of different sample types, or to modify the polarization of light via induced magnetization state in samples. In transparent samples, the Faraday effect can be used to elaborate Faraday rotators, a key element in the design of optical isolators. Along with other MO effects such as Kerr measurements, they provide a non-destructive probe for in-situ measurements.

Spectral dependence of the Faraday MO effect in the visible spectrum along with temperature dependence measurements were performed on a $2\mu\text{m}$ semiconductor epilayer (GaP) grown with embedded metallic ferromagnetic nanoclusters (MnP). The experimental setup was used to investigate the MO properties of the GaP:MnP in the Faraday configuration. Hysteresis curves were obtained by rotating the analyzer at 45 degrees with respect to the polarizer and sweeping the magnetic field from -400 to 400 mT . Small angles of rotation ensure linear variation in transmitted intensity as a function of the rotation angle of the polarization, or applied magnetic field. The angle of rotation must be obtained independently for each applied field, wavelength and temperature.

The total Faraday rotation of the epilayer as a function of wavelength at a temperature of 220K is displayed in figure 2. The free carriers contribution of the GaP substrate has been subtracted. The GaP:MnP epilayer produces a maximum MO effect in the near infrared whereas the substrate has a monotonic decrease in the MO effect as the wavelength is increased. The inset shows the Faraday rotation hysteresis curves at 210K , 270K and 290K at 655 nm . The tunable laser allowed us to investigate the hysteresis signature of the MO Faraday effect at different wavelengths as well as different temperatures.

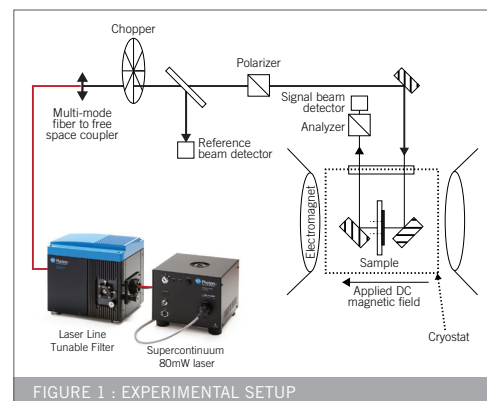


FIGURE 1 : EXPERIMENTAL SETUP

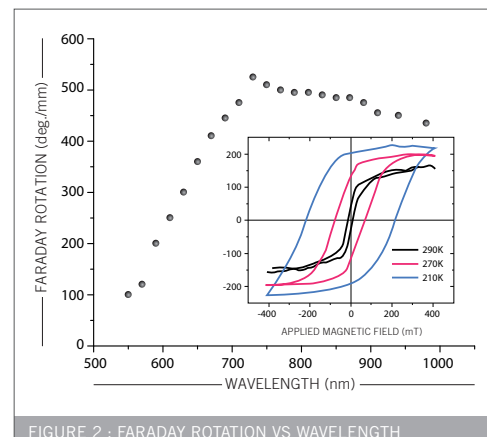


FIGURE 2 : FARADAY ROTATION VS WAVELENGTH