ZnTe single crystal growth for broadband Terahertz applications

Single crystal ZnTe substrates are used for broadband THz generation and detection. THz are electromagnetic waves lying between microwave and infrared region which are invisible, non-invasive, non-ionizing and biologically safe and offer higher resolution than other safe wavelengths. In addition, the interaction of THz with various materials in terms of molecular vibrations and carrier dynamics bestows it with a unique ability to probe and provide material spectroscopic information which is beyond the limits of conventional systems. Moreover, THz transparency of most of non-metallic, plastic materials render its use in imaging of concealed items. Hence, wide range of possible THz applications in various fields, such as spectroscopy, imaging, sensing or scanning, quality control, wireless communication, and basic sciences have started burgeoning which has stimulated extensive research in different frontiers of THz worldwide. However, the realization of THz devices and systems is plagued by non-availability of efficient terahertz source and detectors. Amongst the various techniques for THz generation and detection; broadband THz generation using optical rectification of ultrafast laser pulses and THz detection using electro-optic sampling using non-linear crystals have been one the simplest yet fast and reliable technique used for broadband THz generation and detection. ZnTe owing to its high non-linear susceptibility, high electro-optic coefficient and low THz absorption is the most extensively used non-linear crystal material in various commercial THz systems for broadband THz generation and detection.

With the research on Terahertz burgeoning in both academia and industry in the country; the demand for high quality ZnTe substrates is expected to rise significantly in near future. Presently, ZnTe substrates for THz applications are not available within the country and are being imported at exorbitantly high cost by various users in country involved in THz research and development like TIFR, IITs, IISER, NISER, NPL and many other institutes of national importance. Typically, a 10 x 10 mm^2 (110) ZnTe substrate costs ~ 1800 € with the cost increasing exponentially both with the substrate size and thickness. Moreover, the cost of high resistivity ($\geq 10^4$ Ω-cm) (110) ZnTe substrates is still higher. Keeping the above points under consideration, SSPL has developed the complete single crystal growth and substrate fabrication facility for development of (110) oriented ZnTe substrates. Typical technological parameters/specifications of SSPL developed ZnTe substrates are:

Orientation	(110) ± 0.25°
Size	10 x 10 mm^2 both sides polished *(Up to 18x18 mm^2 substrate have been fabricated presently)*
Thickness	200 microns to 3 mm *(higher thickness also achievable)*
Resistivity	$\geq 10^5$ Ω-cm
THz generation/ detection range	0.1 to 3 THz *(Higher THz ranges possible with thinner ZnTe substrates)*

SSPL fabricated ZnTe substrates have been extensively tested for THz characteristics (THz transmission, THz detection and THz generation) at TIFR, Mumbai and NISER, Bhubaneshwar and were found to perform exceptionally well in comparison to imported ZnTe substrates.