Molecular Structure:

Semiconducting chalcogenide glasses, first produced in the late 1950’s, are normally classified as large covalently bonded network solids that act as a single molecular complex. They exhibit some unique optical and electrical properties.

Compositions:

The following are currently made in 5 inch and 17.40 mm diameter sizes for ULVAC systems.

GST Germanium antimony telluride
SAG Selenium arsenic germanium
GAST Germanium arsenic selenium telluride
TAGS Tellurium arsenic germanium silicon

Development:

In order to harness the extensive capabilities of this material, LTS is performing research and development for future applications with chalcogenide glass to:

- Improve the glass microstructure in chalcogenide targets for higher quality deposition,
- Develop a baseline process for commercial production and application of PRAM

We welcome your inquiries and look forward to working with you on custom formulations

Established in 1989 and based in New York, LTS has been pushing boundaries in the development and implementation of high-purity optical coating materials since its inception.

LTS produces high purity and high performance materials for the optics and fiberoptics, electronics, automotive, aerospace, medical, defense, crystal growth, and fuel cell industries, and are constantly developing new products and applications for our clients. We pride ourselves on our superb materials quality: whether it’s a standard formulation or researching and developing new chemicals and compounds, we work to provide you with products unparalleled in their respective industries.

Our research and development team comprises experts in chemistry, chemical engineering, mechanical engineering, materials science, vacuum engineering, and high-caliber machining. Our production process is vertically integrated from raw materials procurement to the final finishing process, giving us precise control in creating materials to exact specifications.

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SEMICONDUCTING CHALCOGENIDE GLASSES

Optical Coatings from Concept to Commercialization (OC^3)

LTS Research Laboratories, Inc.

Semiconducting Chalcogenide Glasses For Optics, Memory, & PRAM Applications

Applications:

Ultrafast broadband response times, tunable third-order nonlinear refractive index, and optical band gap energy make these materials useful for IR detectors, lenses, optical fibers, and photonic integrated circuits.

In addition to current storage technology, they are also used in emergent Phase Change memory (PRAM) development. An electric current pulse supplies the necessary heat to trigger the glassy-crystal phase transformation from amorphous to crystalline in a matter of nanoseconds. The read-out is performed by utilizing the relatively large differences in electrical resistance of the two phases. The crystalline region may be transformed back by a brief exposure to local heat followed by rapid cooling.

Optics:

Glass	n_0	λ_{gap} (μm)	$n_2/n_2(SiO_2)$	FOM	Reference
$Ge_{25}Se_{75}$	2.7	0.60	120	2	Lenz *et al.* (2000)*
$Ge_{25}Se_{65}Te_{10}$	2.5	0.72	220	1	Lenz *et al.* (2000)*
$Ge_{28}Se_{60}Sb_{12}$	2.61	0.69	360	3	Lenz *et al.* (2000)*
$As_{40}Se_{60}$	2.78	0.70	500	2	Lenz *et al.* (2000)*
$As_{40}Se_{60}$	2.81	0.70	930	11	Harbold *et al.* (2002a)
$As_{39}Se_{61}$	2.81	0.70	660	4	Harbold *et al.* (2002a)
$As_{40}Se_{55}Cu_5$	2.93	0.79	850	5	Harbold *et al.* (2002a)
$As_{25}Se_{55}Te_{20}$	2.52	0.79	470	5	Harbold *et al.* (2002a)
$As_{40}S_{60}$	2.45	0.52	220	>12	Harbold *et al.* (2002a)
$As_{40}S_{50}Se_{10}$	2.49	0.55	380	4	Harbold *et al.* (2002a)
$As_{40}S_{40}Se_{20}$	2.55	0.59	300	8	Harbold *et al.* (2002a)
$As_{40}S_{30}Se_{30}$	2.62	0.62	430	5	Harbold *et al.* (2002a)
$As_{40}S_{20}Se_{40}$	2.70	0.64	460	3	Harbold *et al.* (2002a)
$As_{40}S_{10}Se_{50}$	2.76	0.67	560	7	Harbold *et al.* (2002a)
$Ge_{15.38}As_{30.77}S_{53.85}$		0.49	130	>21	Harbold *et al.* (2002b)
$Ge_{15.38}As_{30.77}S_{32.31}Se_{21.54}$		0.56	250	8.1	Harbold *et al.* (2002b)
$Ge_{15.38}As_{30.77}S_{10.77}Se_{43.08}$		0.61	390	11	Harbold *et al.* (2002b)
$Ge_{20}As_{40}Se_{40}$		0.68	620	4.2	Harbold *et al.* (2002b)
$Ge_{12.5}As_{25}Se_{62.5}$		0.63	450	18	Harbold *et al.* (2002b)
$Ge_{11.11}As_{22.22}Se_{66.67}$		0.63	530	28	Harbold *et al.* (2002b)

*Measured at 1.5 μm.

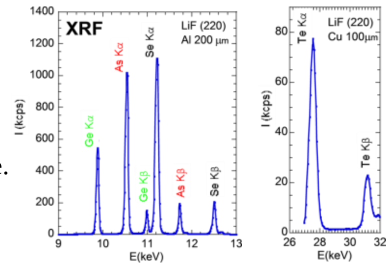
Optical index, n_o, and nonlinearities for chalcogenide glasses measured at 1.55 μm.

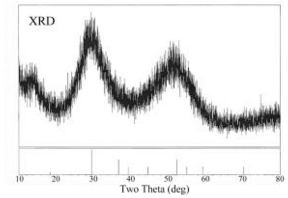
QC Protocols:

are agreed upon by the end-user. Typically LTS conducts the following four experiments to check the materials:

- Powder XRD to confirm the material is fully-reacted, and its amorphous state.
- XRF to check the alloying ratio conforms to customer request.
- Optical microscopy on coupon to discern flaws.
- EDX on coupon to check local composition deviation.

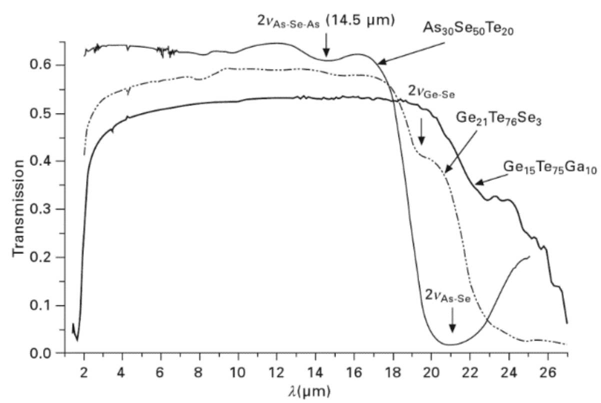
We also offer pair distribution function analysis (based on EXAFS or x-ray diffraction PDF), ICP-AEM and ICP-MS, LECO, DTC, transport and optical measurements.





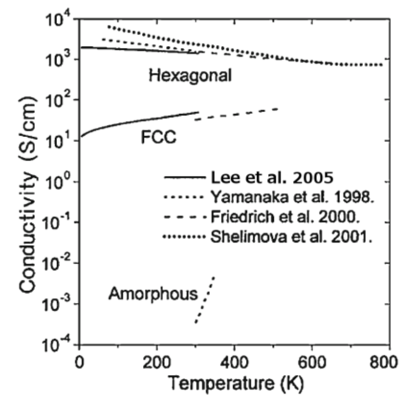
440 mm GAST target
for production environments

Transparency spectra of $As_{30}Se_{60}Te_{20}$, $Te_{76}Ge_{21}Se_3$, and $Te_{75}Ge_{15}Ga_{10}$ glasses (thickness is 2 mm).



References:
Fairman, Ushkov - Chalcogenide Glasses Preparation, Properties and Applications (2014)
Kolobove, Tominaga - Chalcogenides Metastability and Phase Change Phenomena (2012)
A. Abdel-Wahab - Study of The Physical Properties of Some Semiconductor Materials (2012)

Electrical:



Above: Conductivity of $Ge_2Sb_2Te_5$ in different phases. The amorphous and FCC phases are both semiconducting, while the hexagonal phase is almost metallic.

Below: IV curves of a pair of 100 nm thick $In_xSn_{20}Se_{60-x}Bi_{20}$ glass filaments undergoing phase change.

No data could be recorded during the ~10^{-9}s change.