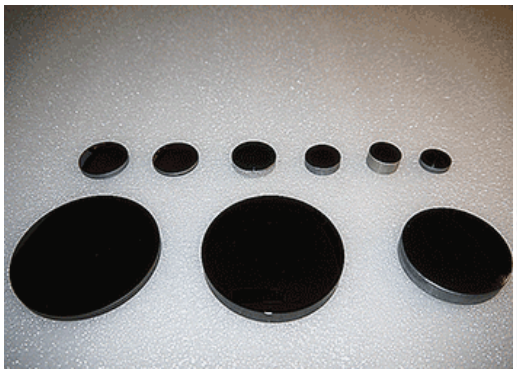
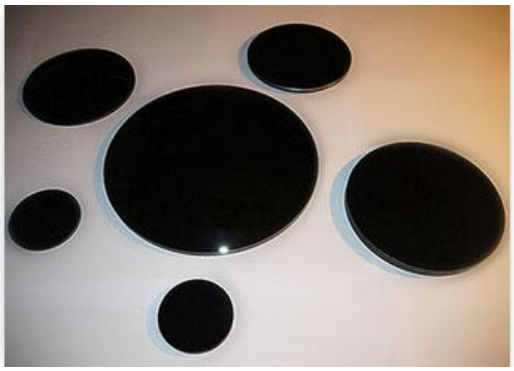
# Germanium lenses

**Germanium lenses (Ge lenses)** is commonly used in IR imaging systems typically operating in the 2 μm to 16 μm spectral range, covers the LWIR (8-12μ m) and MWIR (3-5μ m) **thermal imaging** applications. Gerrmanium has the highest refractive index of commonly available IR-transmitters and has low optical dispersion. This makes it desirable in aspects of lens design where its refractive index allows otherwise impossible specifications to be built. Germanium can be AR coated with Diamond producing an extremely tough front optic, and it is often used as the front optics in lens group. Germanium is more rugged than other IR materials, but caution should be taken for high temperature applications where the material will become opaque in the IR realm as the temperature rises. Beside the general spherical surface lenses, Hangzhou Shalom EO also provide the aspherical surface lenses made by SPDT (Single Point Diamond Turning) technique.

## SPECIFICATIONS

| Specifications | |
|---|---|
| Materials | Optical grade germanium single crystals |
| Diameter range | ~300mm |
| Daimeter Tolerance | +0.0/-0.2mm |
| Thickness Tolerance | +/-0.2mm |
| Surface Quality | 60/40 S/D |
| Frings (N) | 3 |
| Irregularity (delta N) | 1 |
| Centration | 3' |
| Chamfer | 0.1-0.3mmx45 degree |
| Coatings | AR/AR@7-14micro<br>DLC/AR@7-14micro<br>BBAR/BBAR@3-12 micro<br>See coating curves below |

Note: the domes of other specifications is available upon customer's request.



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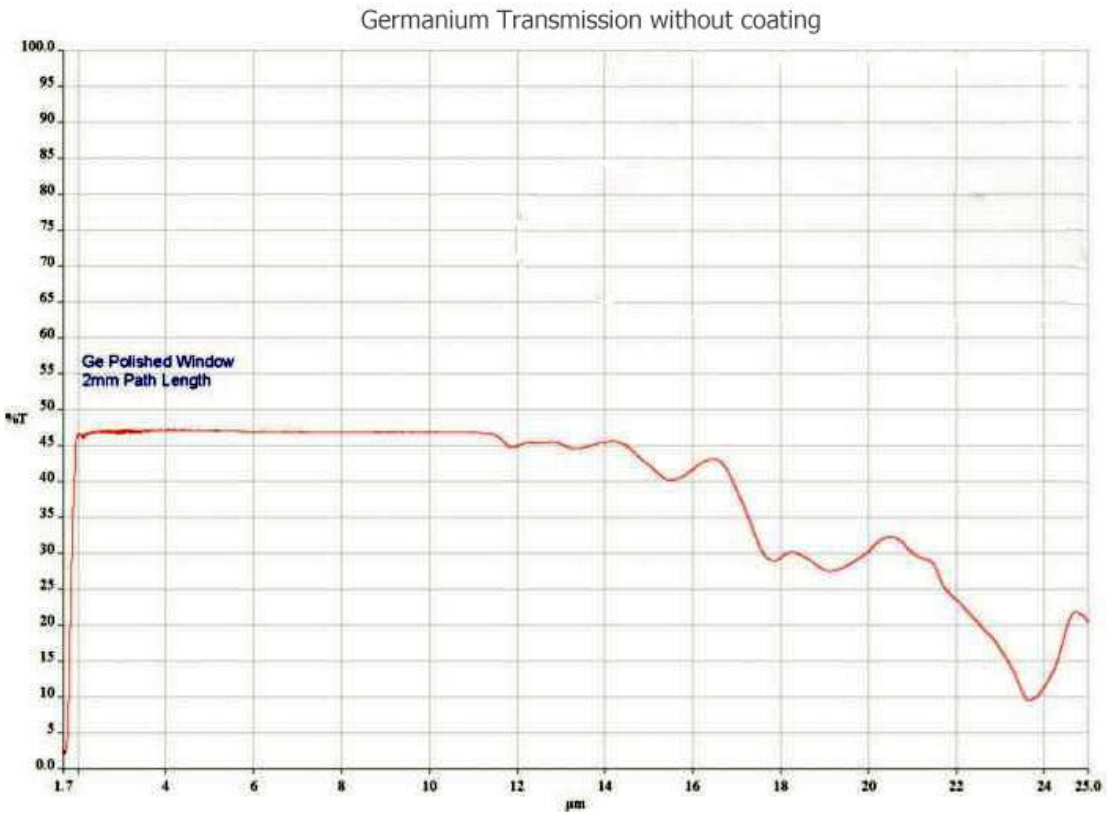
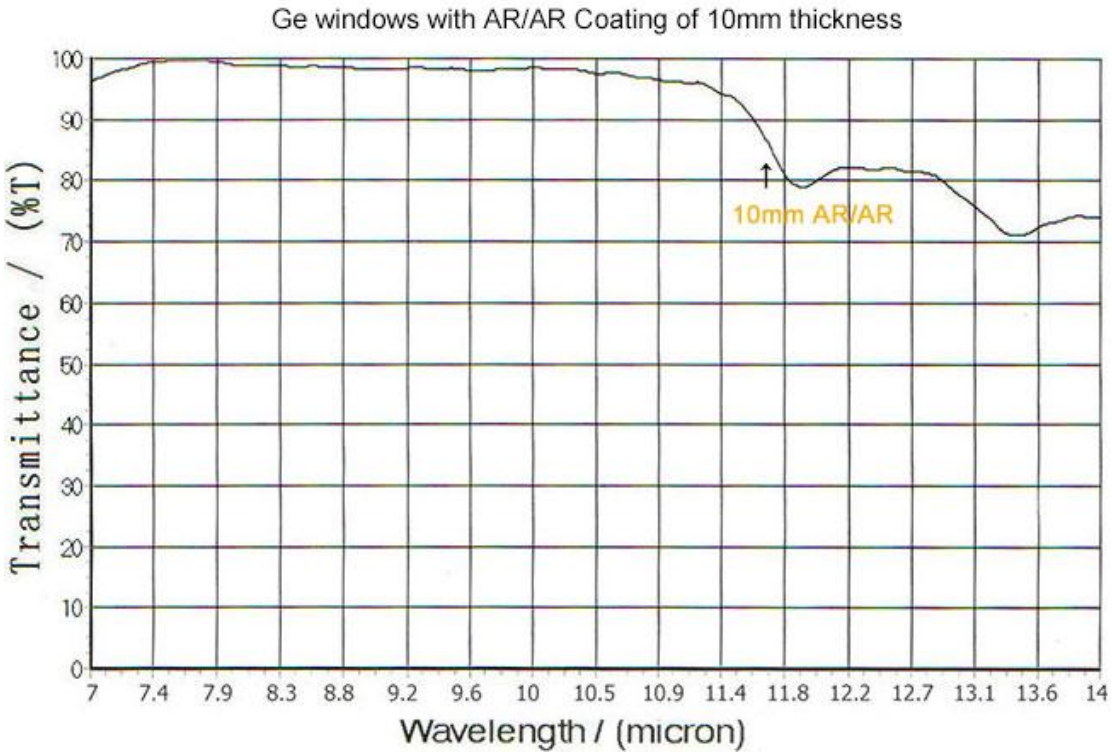
**1.** Transmission curve 1, transmission of Ge windows with no coating




**2.** Transmission curve for Ge windows with coating AR/AR of 10mm thickness



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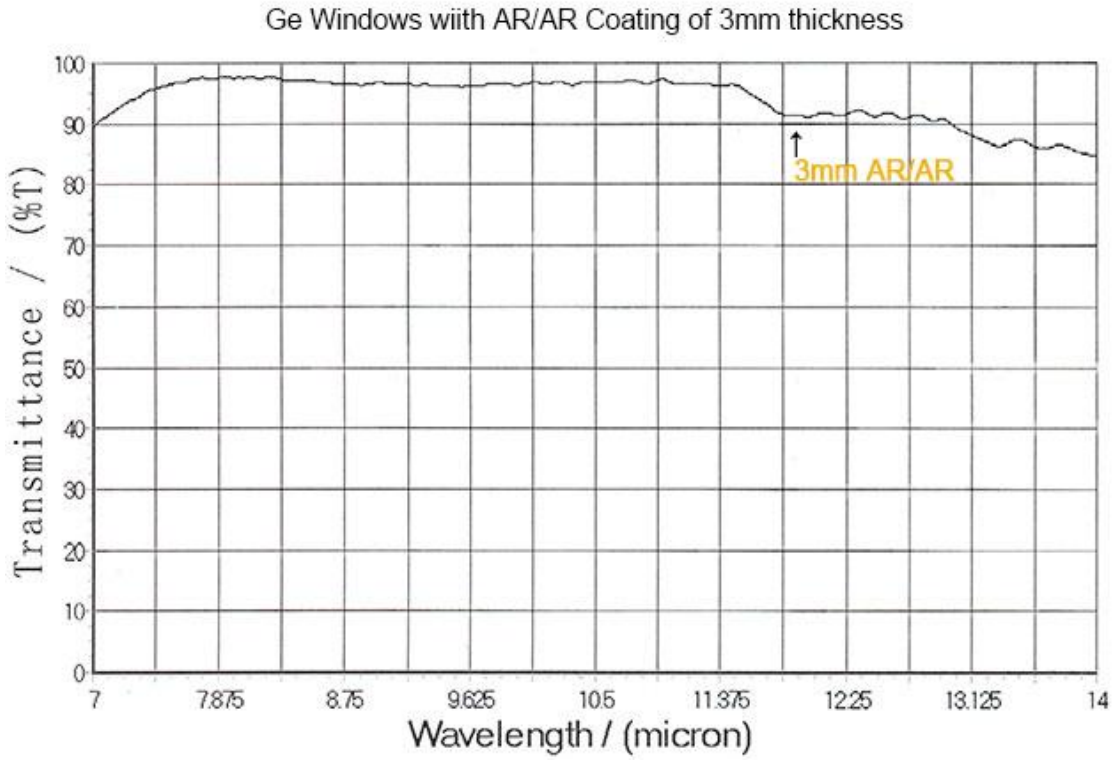
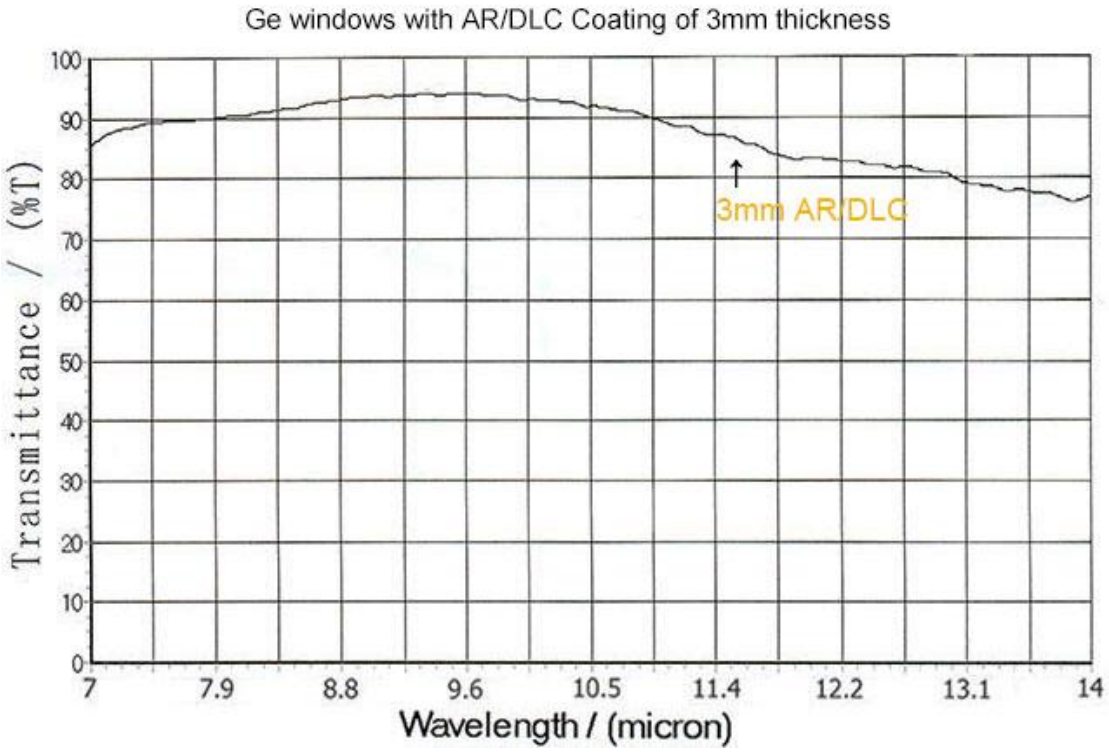
**3.** Transmission curve for Ge windows with coating AR/AR of 3mm thickness




**4.** Transmission curve for Ge windows with coating AR/DLC of 3mm thickness



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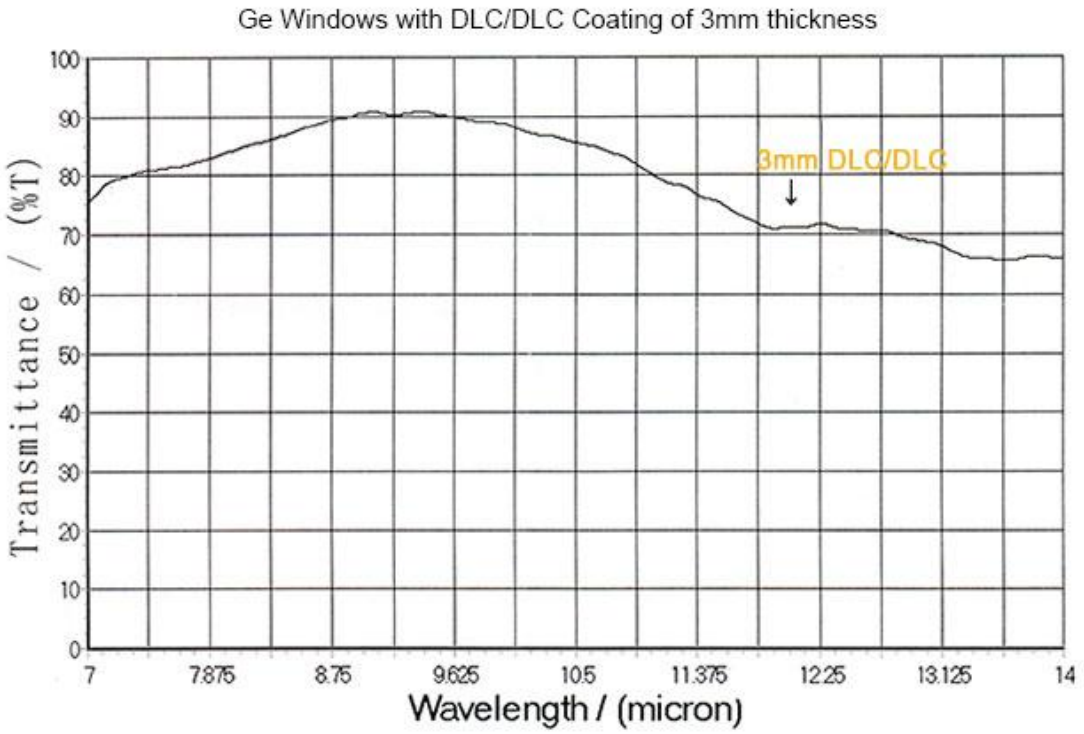
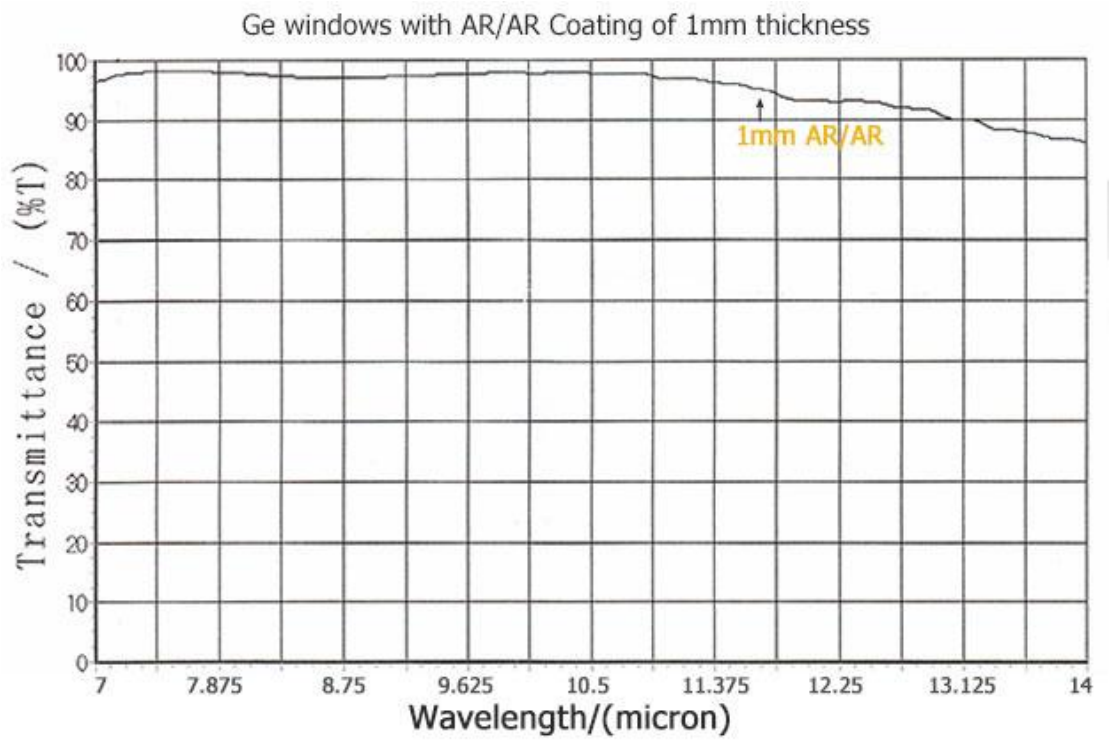
**5.** Transmission curve for Ge windows with coating DLC/DLC of 3mm thickness




**6.** Transmission curve for Ge windows with coating AR/AR of 1mm thickness



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## Features

- **Diameter range: ~ 300mm;**
- **Long wavelength range from 2 to 16 micro;**
- **Fit for both MWIR (3-5 micro) and LWIR (8-12 micro) themal imaging applications;**
- **All types of lenses: plano-convex, plano-concave, doubble convex, double concave and meniscus**
- **With spherical and aspherical lens surface;**
- **Various types of coating available:**
  **AR/AR@7-14um;**
  **DLC (diamond or hard carbon coating)/AR@7-14um;**
  **BBAR/BBAR@3-12um;**
  **Customized coating;**

## Basic Properties

| Physical and optical properties | |
|---|---|
| Transmission Range | 1.8 to 23 μm (1) |
| Refractive Index | 4.0026 at 11 μm (1)(2) |
| Reflection Loss | 53% at 11 μm (Two surfaces) |
| Absorption Coefficient | <0.027 cm-1 @ 10.6 μm |
| Reststrahlen Peak | n/a |
| dn/dT | 396 x 10-6 /°C (2)(6) |
| dn/dμ = 0 | Almost constant |
| Density | 5.33 g/cc |
| Melting Point | 936 °C (3) |
| Thermal Conductivity | 58.61 W m-1 K-1 at 293K (6) |
| Thermal Expansion | 6.1 x 10-6/°C at 298K (3)(4)(6) |
| Hardness | Knoop 780 |
| Specific Heat Capacity | 310 J Kg-1 K-1 (3) |
| Dielectric Constant | 16.6 at 9.37 GHz at 300K |
| Youngs Modulus (E) | 102.7 GPa (4) (5) |
| Shear Modulus (G) | 67 GPa (4) (5) |
| Bulk Modulus (K) | 77.2 GPa (4) |
| Elastic Coefficients | C11=129; C12=48.3; C44=67.1 (5) |
| Apparent Elastic Limit | 89.6 MPa (13000 psi) |
| Poisson Ratio | 0.28 (4) (5) |
| Solubility | Insoluble in water |
| Molecular Weight | 72.59 |
| Class/Structure | Cubic Diamond, Fd3m |


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# Application Notes

**Germanium (Ge)** is a relatively hard, high-density, IR transmitting material that blocks UV and VIS wavelengths but allows IR from 2μm. Germanium has the highest refractive index of commonly available IR-transmitters and has low optical dispersion. This makes it desirable in aspects of lens design where its refractive index allows otherwise impossible specifications to be built. AR coating is recommended.

**Germanium transmits** over 45% between 2-14μm up to $45^0$ C but transmission degrades slowly at $100^0$ C then more rapidly above $200^0$ C. Exposure to higher temperatures can lead to catastrophic failure in the material so Germanium is unsuitable for use in these conditions. Additionally, its relatively high density should be considered where weight is an issue. Germanium has a hardness of HK780, slightly higher than GaAs with which it shares similar mechanical properties.

**Typical applications** for Germanium include thermal imaging where the material can be used as a front optic while its index of refraction makes Germanium useful for wide-angle lenses and microscopes. Additionally, Germanium components can be used for FLIR (Forward Looking Infrared) and FTIR (Fourier Transformed Infrared) spectroscopy systems, alongside other analytical instruments.

**In order to lower the cost and improve** the imaging quality of les assemblies used in thermal imaging cameras, the aspherical surfaces is used in the design of lens group. Hangzhou shalom EO provide the spherical surface lenses made by SPDT (Single Point Diamond Turning) technique, we'll manufacturing the lens optics according to your request.


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