

# CATALOGUE OF GERMANIUM PRODUCTS

 **Shvabe**



Joint Stock Company «GERMANIUM»

GERMANIUM  
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## Germanium IV Chloride (GERMANIUM TETRACHLORIDE - GeCl<sub>4</sub>)

| Quality parameters<br>(analysis) | Types                        |                     |                |                                    | Methods of measurements |              |
|----------------------------------|------------------------------|---------------------|----------------|------------------------------------|-------------------------|--------------|
|                                  | for optical fiber (6N)       | of high purity (6N) | 4N purity      | for optical fiber (6N) high purity |                         |              |
| Element                          | (OF – 6N)                    | TY 48-4-519-89      |                |                                    |                         |              |
|                                  | ppb, max                     | ppb, max            | ppm, max       | ppb, max                           |                         |              |
|                                  | 1. Metal impurities, ppb max |                     |                |                                    | Emission spectroscopy   |              |
| Chromium (Cr)                    | 1                            | 1                   | 0.1            | 1                                  |                         |              |
| Cobalt (Co)                      | 0.5                          | 0.5                 | 0.2            | 0.5                                |                         |              |
| Copper (Cu)                      | 1                            | 1                   | 0.05           | 1                                  |                         |              |
| Iron (Fe)                        | 2                            | 2                   | 0.5            | 2                                  |                         |              |
| Manganese (Mn)                   | 0.5                          | 0.5                 | 0.04           | 0.5                                |                         |              |
| Nickel (Ni)                      | 1                            | 1                   | 0.02           | 1                                  |                         |              |
| Vanadium (V)                     | 0.5                          | 0.5                 | 0.1            | 0.5                                |                         |              |
| Zinc (Zn)                        | 1                            | 1                   | 0.5            | 1                                  |                         |              |
| Aluminum (Al)                    | 1                            | 1                   | 0.1            | 1                                  |                         |              |
| Arsenic (As)                     | -                            | -                   | 1.0            | -                                  |                         |              |
| Total, max.                      | 10                           | 10                  | 10             | 10                                 |                         |              |
|                                  | 2. Hydrogen donors, ppm max  |                     |                |                                    |                         | IR – Fourier |
| H - Cl                           | 5 [3*]                       | 20                  | Not determined | ≤1                                 |                         |              |
| OH                               | 2 [0,1*]                     | 5                   | Not determined | ≤0,2                               |                         |              |
| CH <sub>2</sub>                  | 1 [0,2*]                     | 2                   | Not determined | ≤0,18                              |                         |              |
| CH <sub>3</sub>                  |                              | 2                   | Not determined |                                    |                         |              |
| Total, max.                      | 10 [3.3*]                    | 30                  |                | 1,38                               |                         |              |

|               |  |     |  |     |
|---------------|--|-----|--|-----|
| Price*, \$/kg |  | 495 |  | 550 |
|---------------|--|-----|--|-----|

\*final cost depends on volume and specification, without transport cost.



## GERMANIUM DIOXIDE - GeO<sub>2</sub>

| Quality parameters (analysis)  | Marks                      |                                      |  |          | Methods of determination   |
|--|----------------------------|--------------------------------------|--|----------|--|
|  | GeO <sub>2</sub> standard  | GeO <sub>2</sub> electronic calcined | GeO <sub>2</sub> for PET and Catalysis, others |          |  |
|  |                            |                                      | Soluble  |          |  |
|  |                            |                                      | overdried                                      | calcined |  |
| Apparent density, g/cm <sup>3</sup>  | 1.3-1.7                    | 1.15-1.7                             | 0.5-1.0  | 0.5-0.1  | Volumetry  |
| GeO <sub>2</sub> content, not less than, % weight                                  | 98.0                       | 98.0                                 | 96.5   | 99.5     |  |
| Sum of moisture and ignition loss, not more than, % weight                         | 3.0                        | 2.0                                  | 3.5  | 0.5      | Gravimetry   |
| Chlorine content (Cl <sup>-</sup> ) not more than, %                               | 0.05                       | 0.01                                 | 0.05   | 0.05     | Titrimetrical nephelometrical  |
| Metal impurities content, sum (As, Co, Cr, Cu, Fe, Mn, Ni) not more than, % weight |                            |                                      | 0.0001   | 0.001    | Emission spectroscopy  |
| Sum (As, Co, Cr, Cu, Fe, Ga, Mn, Ni, Al, Si, Mg) not more than, % weight           | 0.0001                     | 0.0001                               |  |          |  |
| Standard solubility in water according to test, not less than, % weight            | -                          | -                                    | 99.9   | -        | Test: 1 g of GeO <sub>2</sub> in 100 ml of H <sub>2</sub> O when boiling under reflux for 1 hour |
| Solubility in ethyleneglycol according to test, not less than, % weight            | -                          | -                                    | 99.9   | -        | 10 g min of GeO <sub>2</sub> for 1 l of ethyleneglycol according to test) <sup>1</sup>           |
| Electronic purity  | 20                         | -                                    | -  | -        |  |
| Grain size, mkm  | less than 50<br>average 30 | less than 50<br>average 30           | less than 20<br>average 10                     |          | laser ultra-microscopy   |



**Average estimated price – 820 \$/kg.**

## GERMANIUM POLYCRYSTALLINE ZONEREFINED

### Quality parameters (measurements):

- Chemical purity — 6N (99.9999%, weight)
- Specific resistivity of polycrystalline zonerefined germanium at  $t = 23^{\circ}\text{C}$  not less than 47 Ohm·cm (measured by Two-Probe Method on lower surface of ingot — SEMI MF 43)

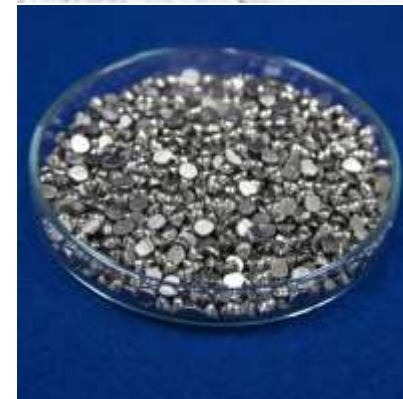
**Average estimated price – 1250 \$/kg.**

## METALLIC GERMANIUM (In form of gray powder)

| Quality parameters  | Analysis | Methods of analysis   |
|---|----------|-----------------------|
| Germanium content, not less than, %   | 99.5     | Photocolorimetry      |
| GeO <sub>2</sub> content, max, % weight   | 0.5      | Photocolorimetry      |
| Chemical purity, sum, not less than, % weight (impurities Fe, Mn, Cu, Ni, Co, Ga, Al, Mg) | 99.999   | Emission Spectroscopy |
| Grain size, $\mu\text{m}$   | < 50     | Laser Ultramicroscopy |

## METALLIC GERMANIUM (In form of granules)

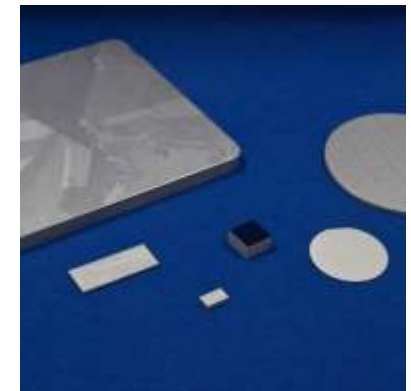
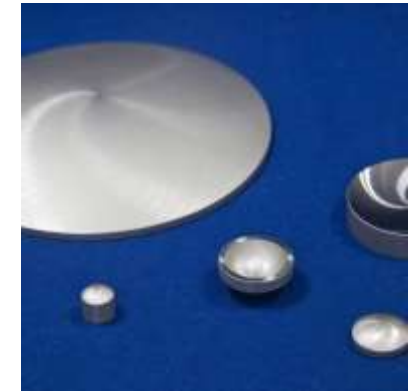
| Parameters  | Analysis |
|---|----------|
| Size, mm  | 3-6      |
| Chemical purity, sum, not less than, % weight (impurities Fe, Mn, Cu, Ni, Co, Ga, Al, Mg) | 99.999   |



## GERMANIUM FOR OPTICAL APPLICATIONS

### Geometrical sizes and tolerances:

| parameter   | sizes   |
|---|---|
| Diameter, mm  | 10÷100<br>100÷200<br>200÷400  |
| Maximum diameter sizes, mm:<br>monocrystalline<br>polycrystalline | 320<br>400  |
| Thickness, sag, length and width, mm                              | 10÷100<br>100÷200<br>200÷400  |
| Chamfer   | 0.1÷0.8 ±0.1  |
| Surface finish, Ra, µm  |   |
| Generated blanks  | ≤ 1.5; ≤ 1.0; ≤ 0.5 (0.3 – instrument D7)   |
| Plano blanks  | ≤ 2.0; ≤ 1.5; ≤ 1.0   |
| Edge chips, mm  | <0.5 mm   |
| ETV, mm   | for diameters till 100 mm<br>for diameters 100÷200 mm<br>for diameters more than 200 mm |
| Parallelism, flatness for plano blanks                            | for diameters till 100 mm<br>for diameters 100÷200 mm<br>for diameters more than 200 mm |



|  |                                       |      |      |      |      |      |      |      |      |      |      |      |      |  |
|--|---------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|--|
| Index of refraction  | 4.0032±0.0002 at λ= 10.6 µm at t=25°C |      |      |      |      |      |      |      |      |      |      |      |      |  |
| Homogeneity of index of refraction   | ≤ 2·10 <sup>-4</sup>                  |      |      |      |      |      |      |      |      |      |      |      |      |  |
| Temperature coefficient of index of refraction   | ≤ 4·10 <sup>-4</sup>                  |      |      |      |      |      |      |      |      |      |      |      |      |  |
| Absorption coefficient, cm <sup>-1</sup>   | 0.03 max at λ= 10.6 µm at t= 25°C     |      |      |      |      |      |      |      |      |      |      |      |      |  |
| Typical transmission on a polished sample (germanium monocrystalline, resistivity 5-40 Ohm*cm) 10mm thick depending on wavelength. | 2,5                                   | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10,6 | 11   | 12   | 13   | 14   |  |
|  | 46,1                                  | 46,3 | 46,5 | 46,5 | 46,5 | 46,3 | 46,0 | 45,9 | 45,4 | 45,2 | 38,0 | 38,5 | 39,0 |  |

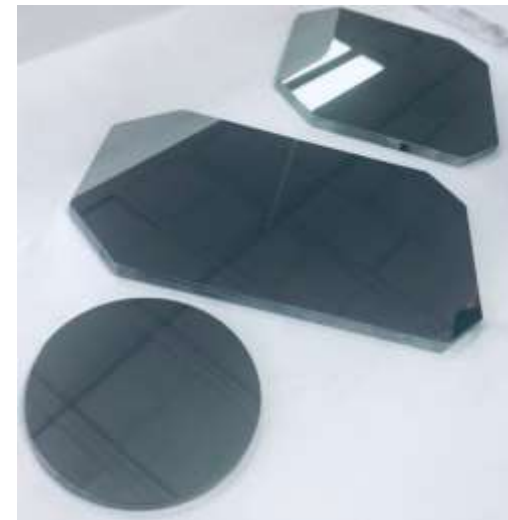
## GERMANIUM MONOCRYSTALLINE

| Quality parameters (measurements) | Mono for solar cells   | Mono of special application                            |
|-----------------------------------|--|--|
| Orientation                       | [100],[100]+6→[111]  | [111], [110], [100] and others                         |
| Conductivity type                 | N,P  | N,P  |
| Dopant                            | Sb, Ga   | Sb,Ga,Au   |
| Resistivity (ρ), Ohm-cm           | as agreed  | 0.01-47  |
| Density (EPD) cm <sup>2</sup>     | < 3· 10 <sup>2</sup>   | <10 <sup>5</sup>                                       |
| Lienage                           | not more than 1/3 diameter, sum of lienage not more of 2 diameters |  |
| Slips                             | non  |  |
| Diameter, mm                      | till 105   | till 100   |
| Length, mm                        | 60 mm  | 40 mm  |
| Special requirements              | as agreed  | density, resistivity, life time and others – as agreed |



## POLISHED GERMANIUM WINDOWS

| Parameter                              | Value                        |
|--|------------------------------|
| Shape                                  | Round<br>Rectangular<br>Oval |
| Diameter / Diagonal                    | from 8 to 300 mm             |
| Thickness                              | from 0.4 to 25 mm            |
| Chamfer                                | Protective / dimensional     |
| Power/Irregularity wave @ 633nm        | (5/1)                        |
| Parallelism (wedge tolerance), arc min | <2                           |
| Scratch/Dig                            | 60/40                        |



**Thank you  
for your attention!**

 **Shvabe**