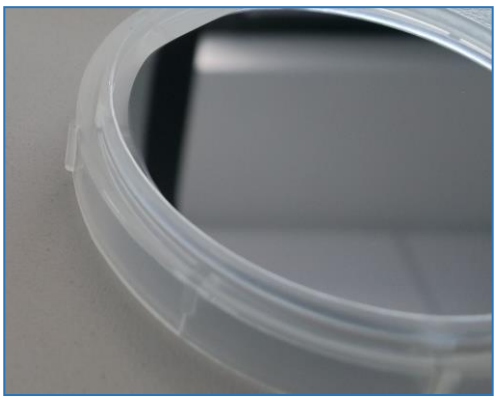
Gallium Arsenide

CMK manufacture Semi-insulating and Semiconducting *Gallium Arsenide* wafers and ingots by LEC (Liquid Encapsulated Czochralsky) or VGF (Vertical Gradient Freeze) growth method. Required electrical parameters are achieved through high purity 6N input material (*Gallium* and *Arsenic*). In order to attain the chosen level of concentration, the dopants like *Zinc*, *Silicon* and *Tellurium* are used.

The production process involves growing of monocrystalline and polycrystalline *Gallium Arsenide* in PBN and High purity quartz crucibles. We offer **monocrystalline** wafers and whole ingots with diameter from 2" up to 4" with quality suitable for epitaxial processing and high-frequency and optoelectronic applications.



CMK, s.r.o.
Sandrická 30
966 81 Žarnovica
Slovakia

phone: +421 45 678 77 11
+421 45 678 77 12
+421 45 678 77 30
fax: +421 45 678 77 23

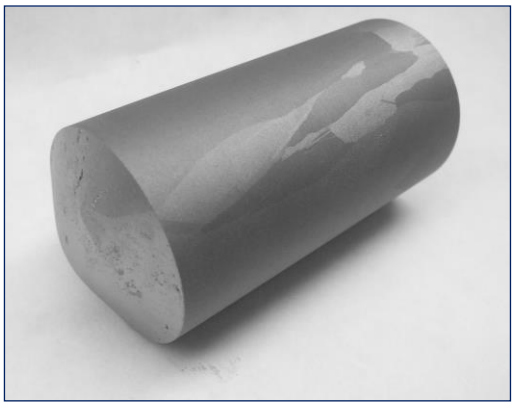
e-mail: sales@cmk.sk
web page: www.cmk.sk
Company ID: 31 622 780
VAT: SK2020478746

registered at Trade Register of Regional Court Banská Bystrica, Section Sro, insert 2466/S

High quality material is produced by trained fully qualified staff to meet customer's often specific needs.

Specification of monocrystalline *Gallium Arsenide*		
	***GaAs* semi-insulating, undoped**	***GaAs* semiconducting, p-type & n-type**
Diameter	wafers: from 2" up to 4" ingots & synthesis: from 2" up to 6"	
Thickness	wafers: from 325 um up to 750 um ingots & synthesis: from 2" up to 6"	
Dopant	-	*Zinc*, *Silicon*, *Tellurium*
Carrier concentration	-	n-type 1 x 10^{16} – 2 x 10^{18} cm^{-3} p-type 1 x 10^{16} – 5 x 10^{19} cm^{-3}
Crystal orientation	(100), (110), (111)	
Off orientation	up to 15°, if necessary >15°	
Resistivity	>1 x 10^{7} Ωcm	>1 x 10^{-3} Ωcm
Hall mobility	>6000 $cm^2V^{-1}s^{-1}$	n-type >1500 $cm^2 V^{-1}s^{-1}$; p-type low
Etch pit density (EPD)	<1 x 10^{4} cm^{-2}	LEC: <7 x 10^{4} cm^{-2} VGF: <5 x 10^{3} cm^{-2}
Surface treatment	wafers: as cut/lapped/etched/single & double side polished ingots and synthesis: as ground/as grown/as cut	
Flat orientation	US SEMI or EJ standard	
Packaging	Standard/Empak/Fluoroware/Fluoroware sealed with N2	

Furthermore, we offer **polycrystalline** *Gallium Arsenide* with diameter from 0.5" up to 4.25" in the form of wafers and ingots. Material is manufactured under high pressure with precise stoichiometry control from high purity input material. Each ingot is analyzed using GDMS with the aim to determine the level of its purity.



CMK, s.r.o.
Sandrická 30
966 81 Žarnovica
Slovakia
phone: +421 45 678 77 11
+421 45 678 77 12
+421 45 678 77 30
fax: +421 45 678 77 23
e-mail: sales@cmk.sk
web page: www.cmk.sk
Company ID: 31 622 780
VAT: SK2020478746

registered at Trade Register of Regional Court Banská Bystrica, Section Sro, insert 2466/S

Polycrystalline *Gallium Arsenide* is used as an input material for further processing and applications.

Specification of polycrystalline *Gallium Arsenide*		
	***GaAs* semi-insulating, undoped**	***GaAs* semiconducting, p-type & n-type**
Diameter	wafers: from 0.5“ up to 4.25“ ingots & synthesis: from 2“ up to 6“	
Thickness	Wafers: from 0.5 mm up to 40 mm ingots & synthesis: from 50 mm up to 100 mm	
Dopant	-	*Zinc, Silicon, Tellurium*
Carrier concentration	-	n-type 1 x 10^{16} – 2 x 10^{18} cm^{-3} p-type 1 x 10^{16} – 5 x 10^{19} cm^{-3}
Resistivity	>1 x 10^{7} Ωcm	>1 x 10^{-3} Ωcm
Hall mobility	> 1 x 10^{3} $cm^2V^{-1}s^{-1}$	n-type >1500 $cm^2V^{-1}s^{-1}$; p-type low
Etch pit density (EPD)	<1 x 10^{4} cm^{-2}	LEC: <7 x 10^{4} cm^{-2} VGF: <5 x 10^{3} cm^{-2}
Surface treatment	wafers: as cut/etched ingots and synthesis: as ground/as grown/as cut	
Flat orientation	US SEMI or EJ standard	
Packaging	Standard/Fluoroware/Fluoroware sealed with N2	

Packaging used for GaAs material

We offer various types of packaging suitable for as cut as well as polished wafers:

- Fluoroware individual container,
- Fluoroware type tray individually sealed in inert atmosphere,
- Empak type 25 wafers box,
- Standard type suitable for packaging of whole ingots and crystals;

CMK, s.r.o.
Sandrická 30
966 81 Žarnovica
Slovakia

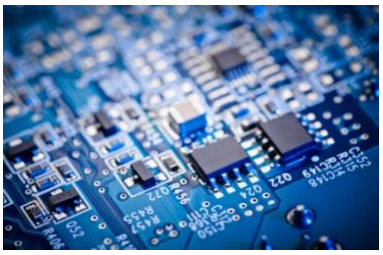
phone: +421 45 678 77 11
+421 45 678 77 12
+421 45 678 77 30
fax: +421 45 678 77 23

e-mail: sales@cmk.sk
web page: www.cmk.sk
Company ID: 31 622 780
VAT: SK2020478746

registered at Trade Register of Regional Court Banská Bystrica, Section Sro, insert 2466/S

Gallium Arsenide field of application

Monocrystalline GaAs



Semi-insulating *GaAs*

- *diameter: 2, 3 and 4 inch wafers & ingots*
- *SI undoped*

Semiconducting *GaAs*

- *diameter: 2, 3 and 4 inch wafers & ingots*
- *SC n-type – Si and Te doped*
- *SC p-type – Zn doped*

Thickness: 350 – 625 µm

Growth method: LEC and VGF

Application field: *LED industry, High-tech industry, MEMS microelectromechanical systems, Solar products, Active components, Integrated circuits, Telecom parts, etc.*

Polycrystalline GaAs

***GaAs* wafers**

- *diameter: 0.5 – 4.25 inch*
- *thickness: 0.5 mm – 40 mm*
- *SI undoped*
- *SC n-type Si and Te doped, p-type Zn doped*

***GaAs* Ingots up to 6“ for VGF growing**

- *diameter: 4.5 – 6 inch*
- *thickness: 50 – 100 mm*
- *SI undoped*
- *SC n-type Si and Te doped, p-type Zn doped*
- *Growth method: LEC and VGF*

Application field: *Polycrystalline GaAs is used as a starting material for the manufacture of GaAs products (LED industry, Fiber optic communication, Microwave circuits, Solar cells application, High efficiency photovoltaic devices, etc.)*

CMK, s.r.o.
Sandrická 30
966 81 Žarnovica
Slovakia

phone: +421 45 678 77 11
+421 45 678 77 12
+421 45 678 77 30
fax: +421 45 678 77 23

e-mail: sales@cmk.sk
web page: www.cmk.sk
Company ID: 31 622 780
VAT: SK2020478746

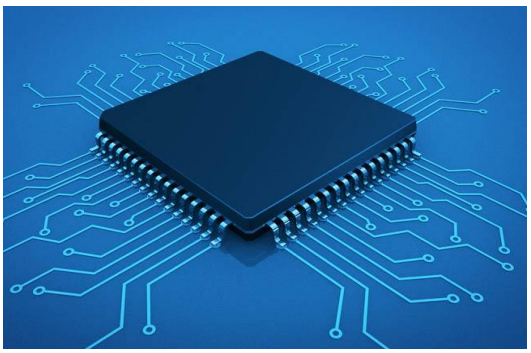
registered at Trade Register of Regional Court Banská Bystrica, Section Sro, insert 2466/S

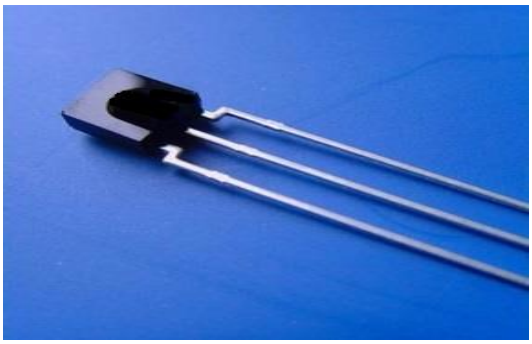
Blanks for Optical Components

Opto *GaAs* wafers

- *diameter: 0.5 – 4.25 inch*
- *thickness: 1 mm – 20 mm*
- *SI undoped*
- *Growth method: LEC*

Application field: *Wireless communication, PHEMT technology, Opto-electronic components (Photodiodes, Phototransistors, Photoresistors, Integrated optical circuits, Optocoupler, Laser diodes, Infrared emitting diodes), Chips, Optical fiber communication, Solar products, etc.*





Illustrated photos

CMK, s.r.o.
Sandrická 30
966 81 Žarnovica
Slovakia

phone: +421 45 678 77 11
+421 45 678 77 12
+421 45 678 77 30
fax: +421 45 678 77 23

e-mail: sales@cmk.sk
web page: www.cmk.sk
Company ID: 31 622 780
VAT: SK2020478746

registered at Trade Register of Regional Court Banská Bystrica, Section Sro, insert 2466/S

Gallium metal

Standard quality of *Gallium* offered by CMK is $6N^+$ which can be directly used in semiconductor industry. The flexibility of our technology allows also the modification of the product purity according to the customer's requirement; therefore, also the *Gallium* in 4N (99.99 %), 6N (99.9999 %) and 7N (99.99999 %) can be produced.

The *Gallium* is packed in a box under pure nitrogen atmosphere and shipped in HDPE bottles of various size and weight.

Gallium recycling

Our company has a long-term experience and skills in *Ga* recycling, mainly from *GaAs* materials (scrap as well as from various types of sludge). This process is important from both – economical and ecological point of view. After recycling process, a *Gallium* in purity of 4N is gained.

Gallium refining

With the increased demands on quantity and quality in semiconductor industry we are also able to offer the service of refining to our customers. The low-pure *Gallium* (3N, 4N) is used as an input material for the refining technology, where it is purified up to 7N (99.99999 %) quality.

CMK, s.r.o.
Sandrická 30
966 81 Žarnovica
Slovakia

phone: +421 45 678 77 11
+421 45 678 77 12
+421 45 678 77 30
fax: +421 45 678 77 23

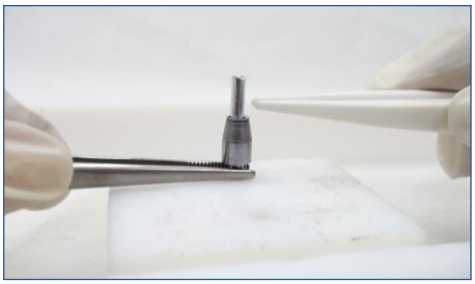
e-mail: sales@cmk.sk
web page: www.cmk.sk
Company ID: 31 622 780
VAT: SK2020478746

registered at Trade Register of Regional Court Banská Bystrica, Section Sro, insert 2466/S

Analytical service

GDMS method

The purity of *Gallium* and *Gallium Arsenide* produced in CMK is tested in the analytical laboratory using Glow Discharge Mass Spectrometry (GDMS) VG 9000, which is an important part of the company.



This service is also offered to our customers. For the testing the solid sample in the form of pin in the size of 2x2x20 mm and the quality at least 2N (99 %) is required. The GDMS operators have wide experience with many different materials, such as: *Al, As, Cu, Co, Ge, In, Ni, Pb, Sb, Si, Sn, Te, Ti, Zn, Zr, GaN, GaP, GaSb, GaTe, InAs, InP, InSb, SiC* and *graphite.*

ICP-OES method

This analytical technique can provide quantitative wide range of elemental composition of different samples, including powders, solids, liquids, and suspensions. Agilent 5110 is an important quality control instrument at CMK. By using this method, it is possible to analyse almost all the elements of the periodic table and it is able to determine the impurities in the concentration of hundreds ppm to ppb units.

XRF method

ED XRF equipment with mono- and polychromatic excitation is used for routine, relatively non-destructive chemical analyses of rocks, minerals, sediments and fluids where the primary composition of the sample is determined.

CMK, s.r.o.
The Gallium Arsenide Company
Slovakia

Sandrická 30, 966 81 Žarnovica, Slovakia

Limits of Detection for *Gallium* analysis using GDMS

No.	Element	Value, ppb wt
1	Li	0.1
2	Be	0.1
3	B	0.2
4	F	4
5	Na	0.2
6	Mg	0.2
7	Al	0.3
8	Si	0.4
9	P	0.5
10	S	0.6
11	Cl	0.4
12	K	4
13	Ca	5
14	Sc	0.03
15	Ti	0.08
16	V	0.03
17	Cr	0.3
18	Mn	0.2
19	Fe	0.3
20	Co	0.05
21	Ni	0.3
22	Cu	0.8
23	Zn	1
24	Ge	10
25	As	0.5
26	Se	6
27	Br	5

No.	Element	Value, ppb wt
28	Rb	0.3
29	Sr	2
30	Y	0.5
31	Zr	0.2
32	Nb	0.2
33	Mo	0.5
34	Ag	40
35	Cd	4
36	In	0.8
37	Sn	5
38	Sb	0.6
39	Te	0.8
40	I	0.3
41	Cs	0.5
42	Ba	1
43	La	0.2
44	Ce	20
45	Hf	0.5
46	W	0.3
47	Pt	0.8
48	Au	5
49	Hg	5
50	Tl	0.1
51	Pb	0.3
52	Bi	0.5
53	Th	0.03
54	U	0.03

CMK, s.r.o.
Sandrická 30
966 81 Žarnovica
Slovakia
phone: +421 45 678 77 11
+421 45 678 77 12
+421 45 678 77 30
fax: +421 45 678 77 23
e-mail: sales@cmk.sk
web page: www.cmk.sk
Company ID: 31 622 780
VAT: SK2020478746

registered at Trade Register of Regional Court Banská Bystrica, Section Sro, insert 2466/S

Limits of Detection

for *Gallium Arsenide* analysis using GDMS

No.	Element	Value, ppb at
1	Li	1
2	Be	0.8
3	B	0.7
4	F	5
5	Na	0.5
6	Mg	0.3
7	Al	0.3
8	Si	0.7
9	P	0.4
10	S	0.4
11	Cl	0.2
12	K	6
13	Ca	8
14	Ti	0.08
15	Cr	0.4

No.	Element	Value, ppb at
16	Mn	0.2
17	Fe	0.2
18	Ni	0.2
19	Cu	0.6
20	Zn	0.8
21	Ge	30
22	Se	6
23	Mo	0.3
24	Cd	4
25	In	< 100
26	Sn	1.3
27	Sb	0.5
28	Te	0.6
29	Pb	0.1
30	Bi	0.1

CMK, s.r.o.
Sandrická 30
966 81 Žarnovica
Slovakia
phone: +421 45 678 77 11
+421 45 678 77 12
+421 45 678 77 30
fax: +421 45 678 77 23
e-mail: sales@cmk.sk
web page: www.cmk.sk
Company ID: 31 622 780
VAT: SK2020478746

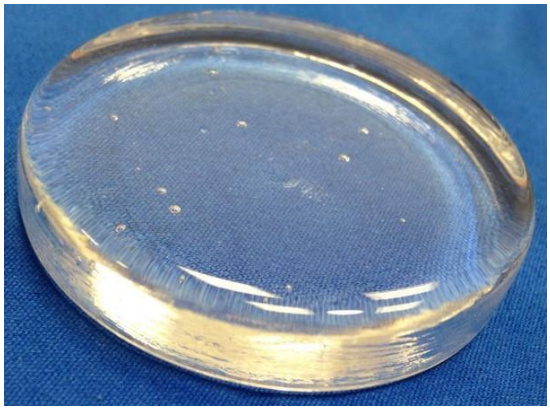
registered at Trade Register of Regional Court Banská Bystrica, Section Sro, insert 2466/S

CMK, s.r.o.
The Gallium Arsenide Company
Slovakia

Sandrická 30, 966 81 Žarnovica, Slovakia

Diboron Trioxide

Diboron Trioxide (B_2O_3) is produced from high purity boric acid. It is used for *GaAs* production. But there is also the demand from the customers, who deal with the *GaP* and/or *InAs* crystal growing processes using both LEC and/or VGF method.



The purity of our product was determined using GDMS and it was evaluated as 99.995 – 99.999 %.

Specification of our standard produced pellets

Product moisture (ppm $_{weight}$)				
Range of water content	I.	II.	III.	IV.
	100 – 300	**301 – 500**	**501 – 1000**	**> 1000**

Deviation is determined to be: +/- 10 %.

Dimension and weight of cylinder and tapered pellets				
Diameter, mm	**50**	**83**	**100**	**138**
Weight, g	**55**	**100 – 200**	**400**	**400 – 700**

Deviation for diameter is determined to be: +/- 2 mm, deviation for weight is determined to be: +/- 3 %.

The water content, shape and weight of pellets can be modified according to the customer's requirements.

CMK, s.r.o.
Sandrická 30
966 81 Žarnovica
Slovakia
phone: +421 45 678 77 11
+421 45 678 77 12
+421 45 678 77 30
fax: +421 45 678 77 23
e-mail: sales@cmk.sk
web page: www.cmk.sk
Company ID: 31 622 780
VAT: SK2020478746

registered at Trade Register of Regional Court Banská Bystrica, Section Sro, insert 2466/S