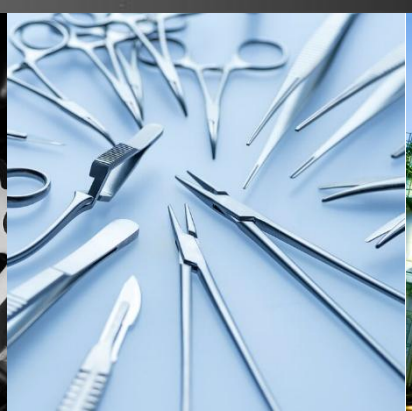
BGH


# Nickel-based Alloys and Special Alloys

# The BGH Group

## TRADITIONAL – INNOVATIVE – FLEXIBLE – CUSTOMER-ORIENTED


Stainless steels, tool steels as well as nickel and special alloys Made in Germany, with diameters from less than a tenth of a millimeter to over a meter - this is our specialty!

For more than 550 years, tradition, innovation, flexibility and customer proximity have been the basis of our production and satisfied customers.

Boschgotthardshütte (BGH), headquartered in Germany and with six production sites in Europe, is an owner-managed manufacturer of stainless steel long products, tool steels and nickel alloys. With our fully integrated production process – from the melt to the finished wire, rod or open-die forging – we guarantee products that meet the highest demands. Our dense, international sales network and service facilities guarantee worldwide availability.

All our sites are certified according to ISO 9001, ISO 14001 and ISO 50001. In addition, we comply with extensive industry and customer approvals and have additional certificates such as IATF 16949 or ISO 17025 depending on the location.

## WE TAKE RESPONSIBILITY

Combating climate change requires ambitious action by the steel sector. To underline our commitment to a sustainable and climate-friendly future, we joined the renowned Science Based Targets Initiative (SBTi) in 2022. BGH's emission reduction targets were validated and confirmed by the SBTi in 2023:

We commit to reducing absolute greenhouse gas emissions according to Scope 1 and 2 by 42 % by 2030, starting from the base year 2021. We are also committed to reduce absolute Scope 3 emissions by 25 % within the same timeframe.

Our science-based goal demonstrates our commitment to building a sustainable economy by doing not what is easy, but what is necessary.

## INDUSTRIES

- Oil & Gas
- Automotive
- Chemical industry
- Nuclear applications
- Power engineering
- General mechanical engineering
- Medical applications
- Household equipment


# Variety in properties and application

Our nickel and special alloys are used in a wide range of applications due to their unique combinations of properties.

The heat and corrosion resistance of our heating resistance alloys, pure nickel and special alloys is essential for fail-safe components in power generation and the chemical and petrochemical industries, but also in household applications. Expansion and glass sealing alloys as well as heating resistance alloys are used just as reliably and with defined physical properties in measurement technology, apparatus construction and electrical engineering.

### INTEGRATED PRODUCTION "MADE IN GERMANY"

We manufacture through a fully integrated production process - from primary melting to the final product. This means that you can obtain your product from a single source!

Thanks to the wide range of systems from the 40MN forging press to rolling mills and wire drawing systems, we can manufacture flexibly and find the optimal process path for your material and your specification. Our product range extends from open-die forgings to rods and wire to fine wire.

During the manufacturing process, all products undergo multi-stage quality controls by our qualified testing personnel. The most important test methods are the control of chemical analysis, mechanical testing, as well as eddy current and ultrasonic testing.

# Special metallurgy for highest purity

Based on the requirements of analysis and purity, the special grades are melted in a vacuum induction furnace (VIM) or in an electric arc furnace (EAF).

The purity of the materials is specifically improved by subsequent electroslag remelting (ESR, P-ESR) or remelting under vacuum (VAR).

It is also possible to combine these processes to meet the highest requirements.

## PRIMARY METALLURGY – SMELTING

The base material of all BGH products is scrap, which is locally collected, processed and sorted. At BGH, we use ingot casting or horizontal continuous casting. The choice of process depends on the material and the dimensions of the final product.

All BGH casting plants use bottom-pouring ingot casting to ensure the best block quality.

### Electric Arc Furnace (EAF)

The scrap is melted down in two 50 t electric arc furnaces. Compared to the production of new steel in the blast furnace, we thus avoid approx. 1.35 t $CO_2$ per ton of crude steel. For our stainless steels, the $CO_2$ savings are even higher due to the high alloy content.

### Vacuum Induction Melting (VIM)

A 10 t vacuum induction multi-chamber furnace (VIM) is available to produce high-purity materials such as nickel-based alloys and special alloys. Mostly, pure metals are used as input materials in the VIM. Melting under vacuum prevents the loss of alloying elements, while degassing takes place at the same time. In this way, extremely high degrees of purity can be achieved.

## SPECIAL METALLURGY – ESR & VAR

To meet the highest requirements for homogeneity and purity, all common remelting processes are available with electro-slag remelting (ESR or P-ESR) and vacuum arc process (VAR). Both remelting processes can be combined or carried out several times.

### Electro slag remelting (ESR) at BGH

The commissioning of the first German ESR test plant in 1962 at the site of the former “VEB Edelstahlwerk 8. Mai” in Freital forms the basis of our more than 60 years of experience with this technology. Through continuous development, we have tailored the ESR process to the needs of our customers, such as the use of shielding gas or remelting under pressure (P-ESR).

In our state-of-the-art 25 t ESR plant, built in 2021, blocks with up to 1250 mm in diameter can be produced (see illustration on the left).

### The electro slag remelting process

In the ESR process, an electrode consisting of the steel to be remelted is deliberately dipped into liquid slag. When the dripping steel passes through the slag, it absorbs impurities. The result is a new block with significantly improved homogeneity and purity.

The use of shielding gases (argon or nitrogen) can also prevent the surface from reacting with oxygen.

### Pressurized electroslag remelting

The pressurized electroslag remelting process (P-ESR) is an extension of the ESR process. It enables the production of steels with such a high nitrogen content that would not be possible though the EAF route. For this purpose, a specific nitrogen-containing solid is alloyed under high nitrogen pressure during remelting.

## Vacuum Arc Remelting (VAR)

To further reduce the content of undesirable trace elements and achieve the highest degrees of purity, a vacuum arc furnace is available in which ingots weighing up to 10 t are produced.

In the VAR process, an electrode is remelted under vacuum by means of an electric arc. The two main differences compared to the ESR process are the work under vacuum and remelting without slag. Due to the possible low melt rates, very good homogeneity is achievable. Trace elements present in the electrode can be partially "evaporated". In addition, degassing takes place.

At BGH, the VAR process is used for special alloys based on iron and nickel.

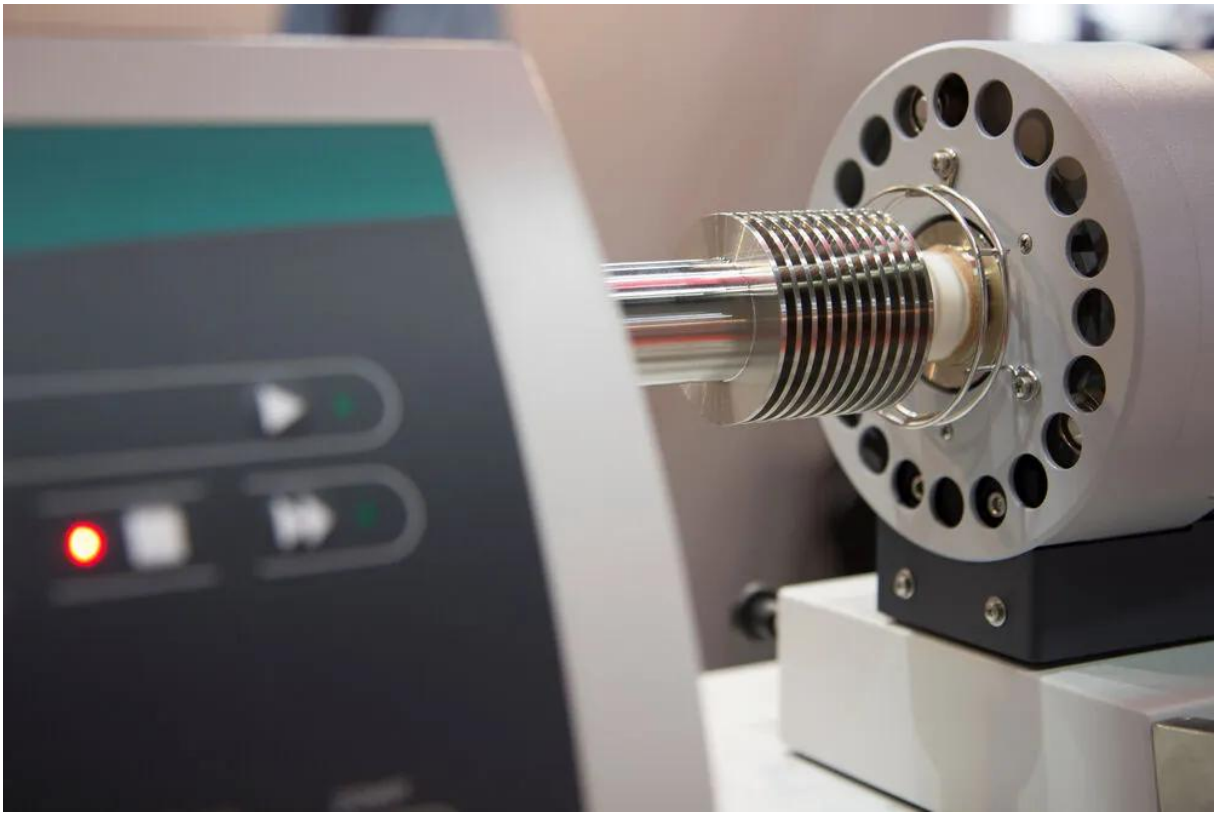

The VAR process offers a variety of advantages:

- Highest achievable degree of purity
- Best homogeneity due to low melting rates
- No risk of slag inclusions
- Additional degassing of the melt
- Evaporation of undesirable accompanying elements

## Triple-Melt

For ultra-pure grades, the VAR process can be combined with the ESR process, as a so-called triple melt process.

# Expansion and glass sealing alloys



### Defined thermal expansion for exact processes

These nickel-iron alloys have a very small coefficient of linear or almost constant thermal expansion over a temperature range. This makes them perfect for the transition between metal and glass or ceramics.

Applications include electrical components in sensor, measurement and energy technology.

In the appendix you will find a complete overview of our grades, such as:

- 1.3912 / Ni36
- 1.3981 / NiCo29-18
- 2.4478 / NiFe47

# BGH THERM resistance alloys

## PREMIUM ALLOYS FOR MODERN HEATING

Our BGH THERM resistance alloys are particularly scale-resistant and suitable for application temperatures of up to 1400 °C.

The high specific electrical resistance of heating resistance alloys leads to a controlled temperature rise when electrical voltage is applied. The radiated heat can be used in a variety of ways - in industrial stoves, heating appliances such as instantaneous water heaters or cartridge heaters, in household goods, electric blankets or seat heaters.

In the appendix you will find a complete overview of our grades, such as:

- FecroTHERM 25-5 / UNS K92500
- FecroTHERM 14-4 / UNS K91670
- NicraTHERM 80-20 / UNS N06003
- NicraTHERM 60-15 / UNS N06004

# Heat-resistant and corrosion-resistant alloys

## Materials for special applications

Mechanical strength even at high working temperatures, good creep properties, resistance to corrosive media - these are all characteristics of these grades. The materials achieve their properties by adding elements such as Mo, Wo, Ti, Nb in combination with high purity.

Heat-resistant and corrosion-resistant materials from BGH can be found in a wide range of applications such as engine and exhaust technology, heat exchangers, valves, in the petrochemical industry or in the offshore sector.

In the appendix you will find a complete overview of our grades, such as.

- 2.4668 / Alloy 718
- 2.4856 / Alloy 625
- 2.4952 / Alloy 80A

# Pure nickel

## Highest purity

Rods and wires made of pure nickel have the best oxidation and corrosion resistance.

The range of applications is diverse and includes, for example, the production of connectors for heating elements or heating coils of spark plugs.

In the appendix you will find a complete overview of our grades, such as:

- 2.4060 / Ni99,6
- 2.4066 / Ni99,2
- 2.4110 / NiMn2

# Appendix

## OVERVIEW OF NICKEL-BASED ALLOYS AND SPECIAL ALLOYS

| Grade no. | Name | Alloy | UNS | Group |
|---|---|---|---|---|
| 1.3912 | Ni36 | | K93601 | Expansion alloy & glass sealing alloy |
| 1.3917 | Ni42 | | K94100 | Expansion alloy & glass sealing alloy |
| 1.3922 | Ni48 | | K94800 | Expansion alloy & glass sealing alloy |
| 1.3981 | NiCo29-18 | | K94610 | Expansion alloy & glass sealing alloy |
| 1.4725 | FecroTHERM 14-4 / CrAl14-4 | | K91670 | Heating resistance alloy |
| 1.4765 | FecroTHERM 25-5 / CrAl25-5 | | K92500 | Heating resistance alloy |
| 1.4767 | FecroTHERM 20-5 / CrAl20-5 | | K92400 | Heating resistance alloy |
| 1.4860 | NicraTHERM 30-20 /NiCr30-20 | | | Heating resistance alloy |
| 1.4864 | X12NiCrSi35-16 | 330 | N08330 | Heat-resistant & corrosion-resistant |
| 1.4876 | X10NiCrAlTi32-21 | 800 | N08800 | Heat-resistant & corrosion-resistant |
| 2.4475 | NiFe46 | | | Expansion alloy & glass sealing alloy |
| 2.0842 | BGH CuniTHERM44 / CuNi44 CuNi44Mn1 | | N04401 C72150 | Heating resistance alloy |
| 2.4060 | Ni99,6 | Nickel | | Rein-Nickel |
| 2.4066 | Ni99,2 | 200 | N02200 | Rein-Nickel |
| 2.4068 | Ni99 | 201 | N02201 | Rein-Nickel |
| 2.4110 | NiMn2 | 212 | N0212 | Rein-Nickel |
| 2.4360 | NiCu30Fe | 400 | N04400 | Heat-resistant & corrosion-resistant |
| 2.4375 | NiCu30Al | K500 | N05500 | Heat-resistant & corrosion-resistant |
| 2.4472 | NiFe45 | | | Expansion alloy & glass sealing alloy |
| 2.4478 | NiFe47 | | | Expansion alloy & glass sealing alloy |
| 2.4486 | FeNi48Cr6 | | | Expansion alloy & glass sealing alloy |
| 2.4602 | NiCr21Mo14W | C22 | N06022 | Heat-resistant & corrosion-resistant |
| 2.4610 | NiMo16Cr16Ti | C4 | N06455 | Heat-resistant & corrosion-resistant |
| 2.4642 | NiCr29Fe | 690 | | Heat-resistant & corrosion-resistant |
| 2.4658 | NicraTHERM 70-30 | | N06008 | Heating resistance alloy |
| 2.4662 | NiCr13Mo6Ti3 | 901 | N09901 | Heat-resistant & corrosion-resistant |
| 2.4668 | NiCr19Fe19Nb5Mo3 | 718 | N07718 | Heat-resistant & corrosion-resistant |
| 2.4669 | NiCr15Fe7TiAl | X-750 | N07750 | Heat-resistant & corrosion-resistant |
| 2.4816 | NiCr15Fe | 600 | N06600 | Heat-resistant & corrosion-resistant |
| 2.4819 | NiMo16Cr15W | C-276 | N10276 | Heat-resistant & corrosion-resistant |
| 2.4851 | NiCr23Fe | 601 | N06601 | Heat-resistant & corrosion-resistant |
| 2.4852 | NiCr20FeMo3TiCuAl | 925 | N09925 | Heat-resistant & corrosion-resistant |
| 2.4856 | NiCr22Mo9Nb | 625 | N06625 | Heat-resistant & corrosion-resistant |
| 2.4858 | NiCr21Mo | 825 | N08825 | Heat-resistant & corrosion-resistant |
| 2.4867 | NicraTHERM 60-15 / NiCr60-15 | | N06004 | Heating resistance alloy |
| 2.4869 | NicraTHERM 80-20 / NiCr80-20 | | N06003 | Heating resistance alloy |
| 2.4951 | NiCr20Ti | 75 | N06075 | Heat-resistant & corrosion-resistant |
| 2.4952 | NiCr20TiAl | 80A | N07080 | Heat-resistant & corrosion-resistant |

## QUALITY / ENVIRONMENT / ENERGY

- ISO 9001
- ISO 14001
- ISO 50001
- IATF 16949
- Approvals of ABS, BV, DNV ...
- Customer-specific approvals

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MADE IN GERMANY
with more than 80 % recycling share

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