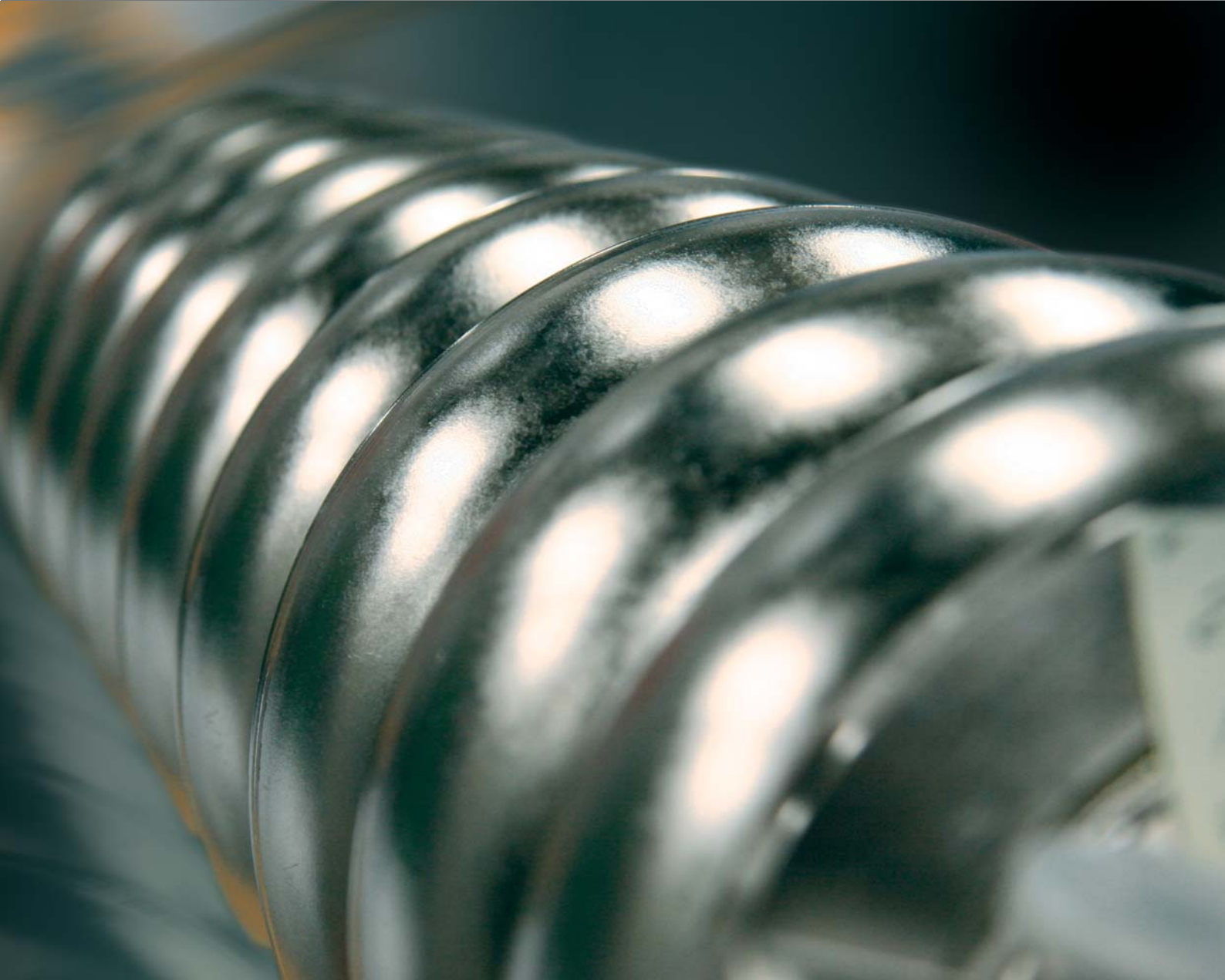


**Heraeus**



**RRR Niobium for Accelerator Technology**

# The frontiers of purification

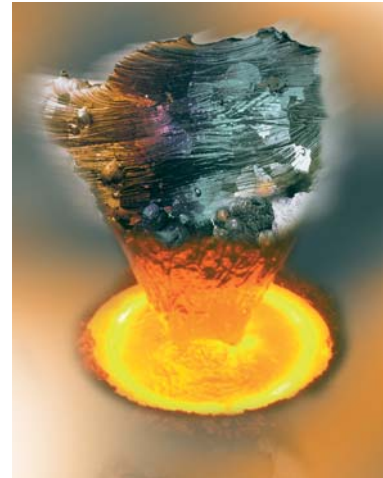
## – RRR niobium by W. C. Heraeus



Nb RRR ingot with defined coarse-grain structure



SQUID (Superconducting Quantum Interference Device)



Electron beam melting of niobium

Whenever expertise in special metals technology has been in demand – Heraeus has stood out for over 150 years as a leader in the technology of precious metals and special metals and materials.

We specialise both in the melting of ultra-pure niobium ingots with RRR values of 300 and more in our own electron beam furnace and in the production of semi-finished products such as seamless tubes which are needed especially in RF superconducting applications.

RRR (Residual Resistivity Ratio) is the reference value for the thermal conductivity and is determined as the ratio between the electrical conductivity at room temperature and the electrical conductivity at the critical temperature (9.4 K).

In its pure form the metal niobium is used in the field of radio frequency superconductivity for the fabrication of resonators, so-called cavities. In fundamental research, subatomic particles (electrons, positrons, protons) are accelerated by means of these cavities in ring accelerators or linear colliders to velocities approaching the speed of light.

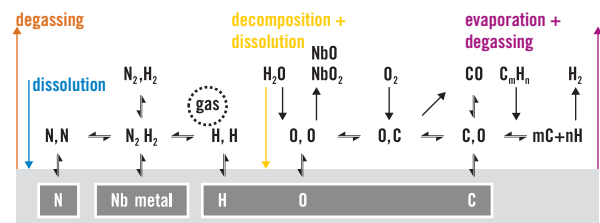
The use of ultra-pure niobium materials with high thermal conductivity in the construction of these cavities is opening

up a new generation of accelerators with high acceleration gradients. The unique quality of RRR niobium materials is achieved by a substantial reduction in the interstitially dissolved non-metals (C, O, H, N).

### Gas reactions with Nb metal

Gas-metal reactions between molten Nb metal and vacuum containing  $H_2$ ,  $N_2$ ,  $O_2$ ,  $H_2O$ ,  $CO$ ,  $C_mH_n$

- Nitrogen  $N_2$  (molecular)
- Oxygen  $NbO / NbO_2$
- Hydrogen  $H_2$  (molecular)
- Carbon  $CO$



During EB purification metals with a lower boiling point than Nb are depleted by evaporation; those with a higher boiling point are enriched.

All gases are being continuously exchanged at the hot metal surface. The reduction of these gases is influenced mainly by the vacuum prevailing during melting.



The leading position of W. C. Heraeus and the high purity of our RRR niobium are guaranteed by the combination of the advanced melting process under high vacuum in our own electron beam furnace and our numerous unique analysis capabilities. A few are outlined below:

#### **Gas analysis in solid materials**

- Precise determination of traces of C, O, H, N and S in the bulk by fusion extraction using the platinum flux technique
- Determination of moisture and carbon on the surface

#### **Mechanical and non-destructive testing methods**

- Tensile strength, bending strength and hardness tests
- Ultrasonic testing
- SQUID (eddy current testing unit with superconducting magnetic field sensors)

#### **Metallography**

- Qualitative and quantitative investigations of polished sections
- Microhardness and low-load hardness tests

#### **Surface analysis**

- Scanning electron microscopy and X-ray microanalysis
- Scanning Auger microanalysis

For superconducting applications W. C. Heraeus offers RRR niobium as semi-finished products in various forms, geometries and sizes. From ingots and sheetbars to bars and rods. Rolled sheet is offered in cooperation with a partner. As a speciality W. C. Heraeus has developed a process for the manufacture of tubes, coupler housings and other formed parts which are produced without weld joints.

One of the latest technologies at W. C. Heraeus is the EB melting of ingots with a defined coarse-grain structure. Discs cut from these ingots can be used directly for further processing to cavities.

Whatever you need for your RRR niobium application – all decisive criteria speak for W. C. Heraeus.

Please contact us.

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