NIBSORB®: A coating for the production of absorber elements subjected to corrosion.

Matthias Patzelt

Metallveredlung GmbH & Co. KG, Solingen, Germany

The concept

NIBSORB® technology stands for an application-specific process for the production of absorber elements. An electrolytic plating process is used to incorporate the neutron poison boron carbide very homogenously and in high concentration into a thick nickel coating. Highly absorbent and corrosion-resistant coatings can be achieved in this way. Applied to base materials of any shape and size, these coatings allow absorbers to be developed which are carefully tailored to the requirements in any given case.

Fig. 1 clearly shows the compound system. It shows the Nickel Matrix with B_4C-Composites with a thickness of 650 µm on a stainless steel base. The concentration of neutron poison achieved in this case is 22 Vol.-%. Fig. 2 is an enlarged illustration of the homogenous dispersion of the neutron poison.

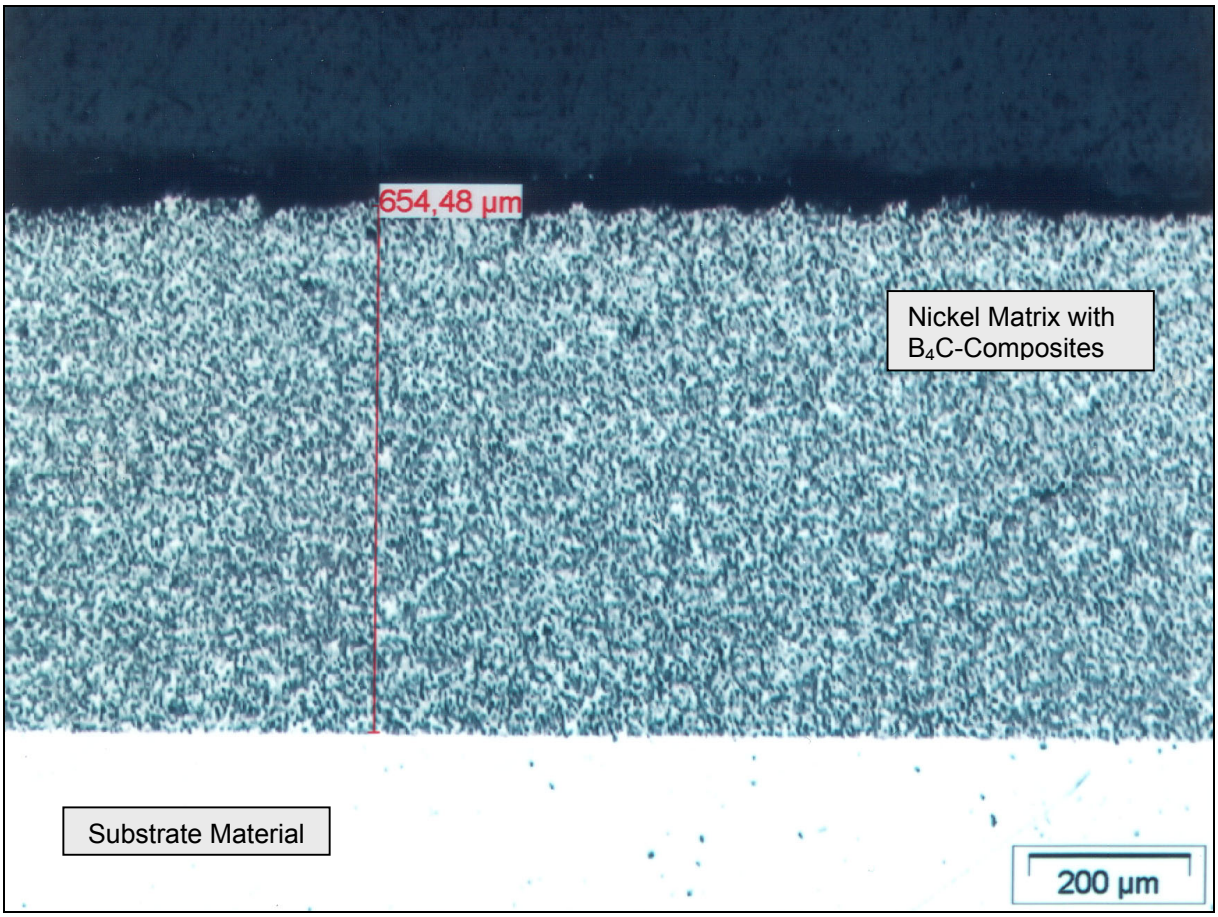

Fig. 1: Grinding Pattern of the NIBSORB® Coating

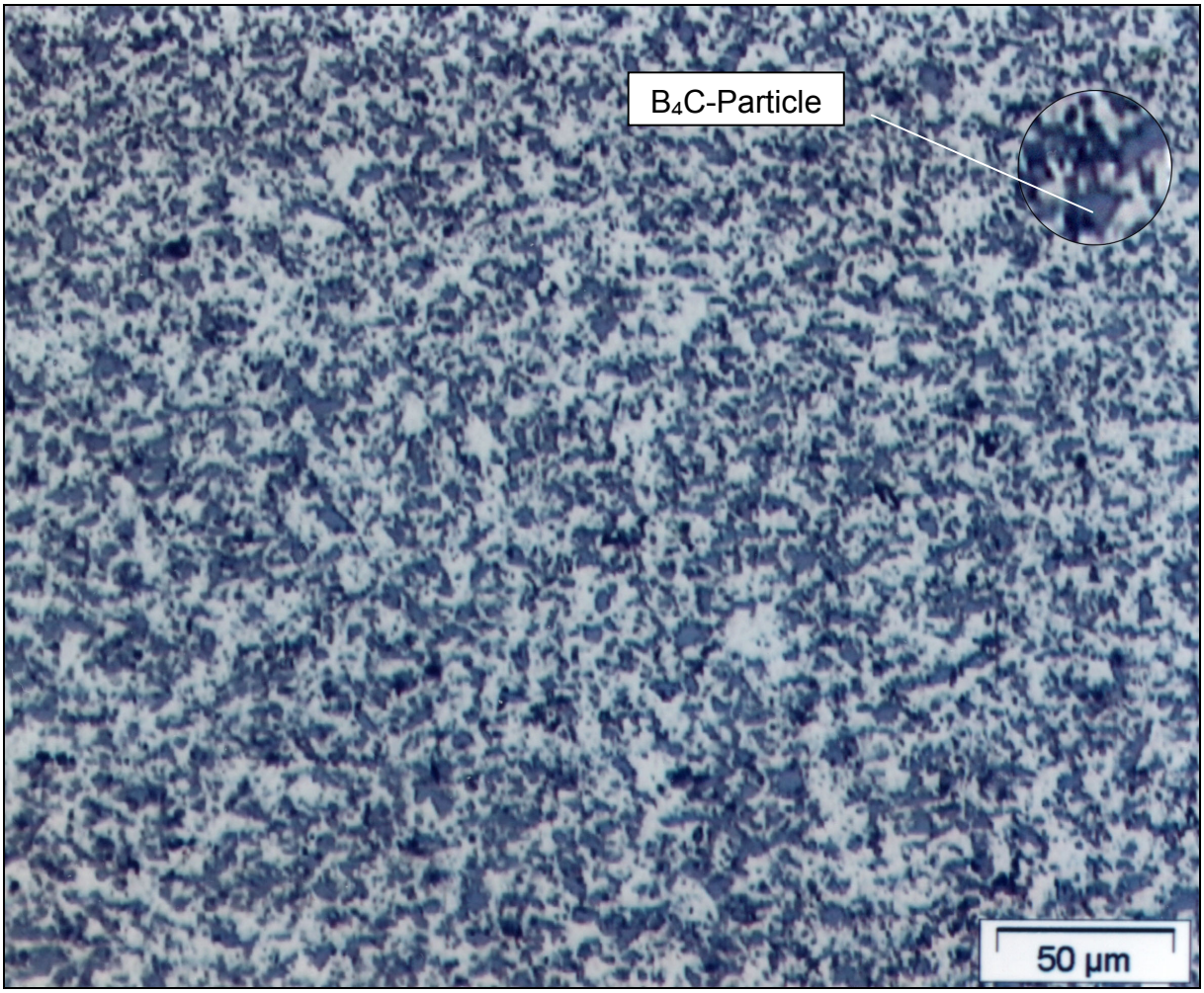

Fig. 2: Homogenous dispersion of the neutron poison in the coating

The coating

The requirements and demands placed on the properties of a NIBSORB® coating result from the particular function of the component to which it is to be applied and the particular case of application. With the aid of a spectrum of total layer thicknesses ranging from 100 to 4000 µm, correct selection of the solid substance to be deposited (conventional or isotope-enriched) and technically meaningful incorporation rates of 15 – 30 volume percent, extremely effective and neutron absorbing coatings can be achieved. The absorbing properties are equivalent to those of those ones produced by the conventional routes but with very small layer thicknesses. The results are significant savings in weight and space.

Furthermore, an improvement in conventional material properties is achieved by the combination of a solid, but still viscous, nickel matrix with a hard, finely dispersed non-metallic element, namely the neutron poison. The hardness increases by at least 15% and the wear resistance improves to a level comparable with that of hard chrome.

Another characteristic is the high chemical and electrolytic resistance of NIBSORB®. This is a decisive factor for wet storage applications.

The requirements of the NIBSORB® coating are listed below:

- Evidence of adhesion on the substrate
  (Tensile Testing, Detention tensile testing , Thermal shock test with 400°C, Temperature change examination, drop test)
- The unanimity of the surface (no pores) and the homogeneous dispersion of B_4C in the deposition.
  (Surface topography : Ra<4µm, Metallographic, light-microscope evaluation)
- The neutron screen
  (Neutron absorbing testing by the KFA Jülich)
- Uniformity of deposit thickness
  (Metallographic evaluation, Ultrasonic measurement)
- Residual stress state
  (Borehole method and Strain gages: small residual tensile strength)
- Abrasion resistance by mechanical stress (e.g. during transport)
  (Taber®-Abraser-Tribometer)
- Sufficient penetration resistance
  (Hardness test: 320 – 350 HV0,1)
- Temperature resistance up to 400°C
  (Metallographic evaluation)
- Corrosion resistance to environment conditions such as spent fuel pools containing boron acid
  (Current density/potential curves)

The technology

To produce coatings of this kind, requirements include a modified electrolyte and an installation geared up to the technical specifications of dispersion coatings. The system must guarantee that the neutron poison supplied to the electrolyte in high concentration will be supplied to the substrate material as finely as possible. The chemistry and installations required for this are not commercially available and had therefore to be developed. The result is a 6 m high process bath with a volume of 3000 l electrolyte. In this plant the Metallveredlung GmbH & Co. KG is able to coat absorber shafts up to 5 m in length homogenously and with a consistent coating thickness.

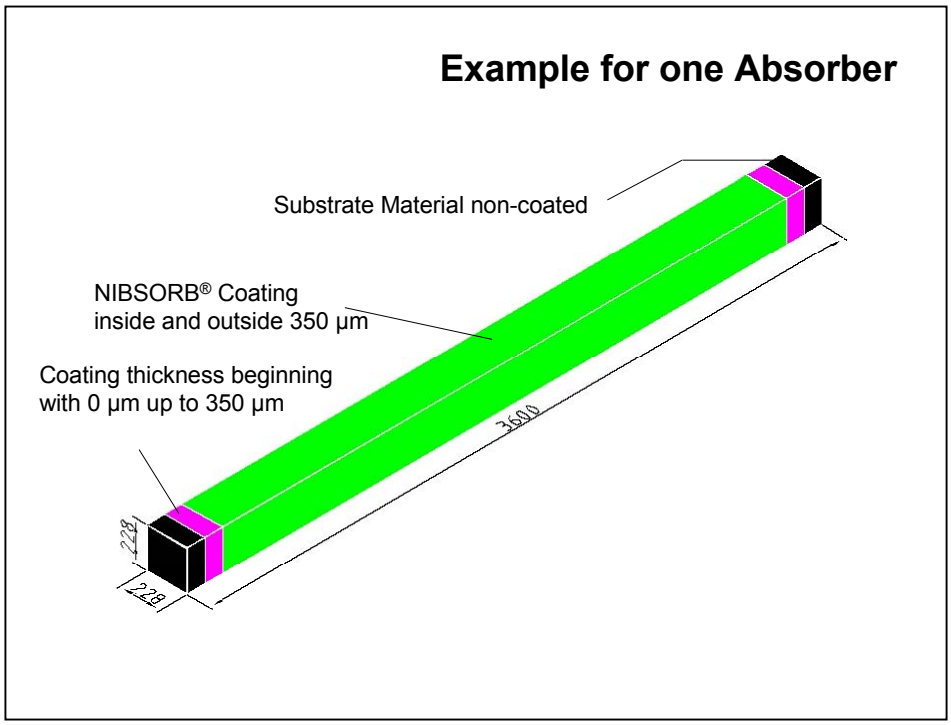

Fig. 3: Absorber shaft

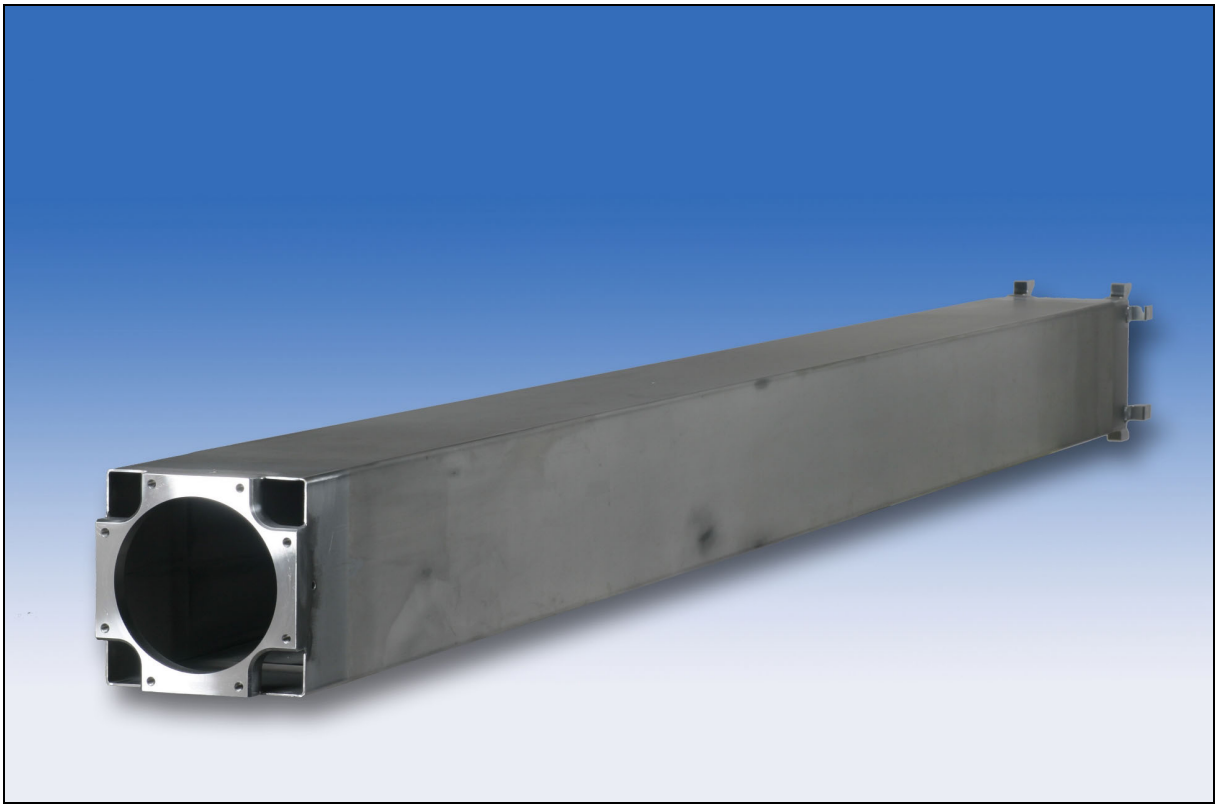

Fig. 4: Absorber shaft for use in a nuclear power station in Germany

Fields of Application:

NIBSORB® is used in applications in which screening of radioactive material from nuclear reactors is needed:

- Transport and/or dry storing: Transport and storage containers
- Wet storage: decay tanks in nuclear power stations

MTV MeTallVeredlung in Solingen, Germany, is a medium-sized company active in the field of surface enhancement. The focal points of its work are the autocatalytic and electrolytic coating with metal of precision components for the fields of mining, reactor engineering and printing machines as well as general mechanical engineering. The coating technics are supplemented by chemical and electrochemical treatment processes preceding and/or following the coating process as well as by mechanical surface treatment processes including turning, grinding and polishing

MeTallVeredlung
GmbH & Co. KG

Höhscheider Weg 25
D-42699 Solingen
Telefon +49-(0)212-262090
Telefax +49-(0)212-66983
eMail: info@mtv-gmbh.com
Internet: www.mtv-gmbh.com