

Over 100 special alloys

In Hanau, since 1923, vacuum melting processes have been employed to produce metal alloys of extreme purity and high-precision tolerances. These special alloys based on iron, nickel and cobalt are also processed into wires and bars.



Mumetall rings are used as flux-guiding elements in current sensors
Photos: Vacuumschmelze

The focus of Hanau-based company Vacuumschmelze GmbH & Co. KG is far away from off-the-shelf products. Batch sizes of the custom wire and bar materials produced by the company are commonly only a few hundred kilograms, or even less for small diameters products. Wires in the range of 0.2 to 5mm, and bars from 2.5mm upwards are available.

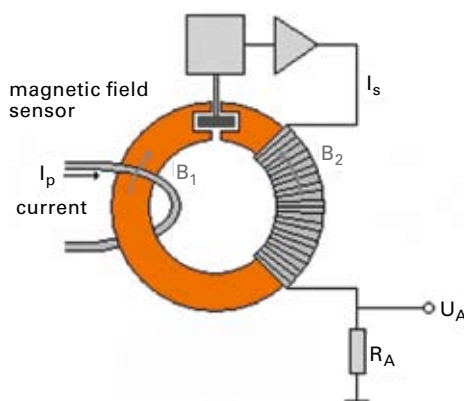
Although the majority of materials are based on the same core ferromagnetic elements, the range of products is extremely diverse and includes items for the following application areas:

- soft magnetic materials
- ductile permanent magnets
- spring alloys
- sealing alloys
- custom alloys.

Whilst plain steel or iron alloys are most commonly used as soft magnetic materials, these products cannot keep pace with the ambitious industry requirements for precision and miniaturization. In these cases, the company's nickel-iron (NiFe) and cobalt-iron (CoFe) alloys may provide the solution. An example is the use of Mumetall for key components in current sensors. Offering ultra-high permeability of 250,000 plus low coercive field strength of 0.015A/cm, Mumetall supports the design of sensitive and high-precision current sensors that are essential to today's electronics and energy management.

Another example exploits the high saturation polarity of CoFe alloys such as Vacoflux 17, making them an ideal choice for electro-magnetic actuators and electro-magnets. The high magnetic induction values of CoFe alloys enable them to be used in miniature dynamic actuator systems with the potential to reduce energy usage. Vacoflux CoFe materials are a particularly useful solution for applications where installation space is at a premium, such as in diesel fuel injection systems.

In addition to soft magnetic alloys, Vacuumschmelze also produces ductile permanent magnets. Crovac[®], is a highly ductile material that can be supplied as wire or trimmed pins to provide for example, an



Circuit diagram of current sensor.

affordable alternative to conventional materials in bi-stable relays.

Other highlights include ultra-high-strength spring materials. For example, any modern, high-quality mechanical clock or watch has a mainspring of Nivaflex, the only material offering extreme hardness plus residual ductility that ensures ultra-long life even for springs that are subject to high alternating loads. Nivaflex is non-magnetic and corrosion-resistant and has hardness levels of up to 800HV. Nivaflex is also commonly used for pivot points in water meters or micromotor axles.

Further development of Nivaflex led to the advanced spring material Duratherm 600, which can withstand application temperatures up to 600°C with only minor loss of hardness. This combination of properties is ideally suited to spring elements in vehicle exhaust gas systems where stainless steel springs would fail and temperature-resistant materials such as Inconel would corrode.

Alternative to beryllium-copper

Vacuumschmelze's newest development is Duracon 17A, a contact spring material with hardness of up to 1800MPa and conductivity of 6MS/m. Duracon is the first ultra-hard yet eco-friendly alternative to beryllium-copper alloys. This hardness, together with Duracon 17A's exceptional stress endurance, enable its use for long-life hardness test probes, a great benefit for the field of electrical measurement technology. Dura-



Heating coil in diesel glow plugs with control element of Vacon CF8,

con can utilise existing tooling designed for CuBe springs or offer further miniaturisation possibilities due to the ability to achieve smaller bending radii than with CuBe. Springs made of Duracon 17 can also be used at operating temperatures of up to 250°C, for example as connectors adjacent to combustion engines.

Whilst spring materials are optimised to deliver maximum hardness, sealing alloys are designed for high-precision thermal expansion – a vital property in applications involving glass and ceramic materials. Vacovit and Vacon alloys can be customized to offer precisely controlled expansion coefficients that increase incrementally from near-zero to approximately $12 \times 10^{-6} \text{K}^{-1}$. A classic field of application for Vacovit wire is that of reed relays, for which the material's double function as both sealing alloy and magnetizable contact fulfils all the specifications. Vacovit materials produced by metal powder processing offer particularly outstanding features; by completely eliminating accompanying elements such as silicon, manganese and aluminium, they offer advantages in the application of soldering compounds and contact layers and also maximize the lifespan of relays.

Vacon alloys are used in combination with ceramic materials. Their high-precision expansion behaviour is particularly important in the semiconductor industry for applications such as diodes, transistors and integrated circuits, where linear expansion coefficients of 5 to $8 \times 10^{-6} \text{K}^{-1}$ serve to extend the lifespan of power entry points.

Materials – the key to progress

Vacuumschmelze also develops all-new custom alloys for special applications. Vacon CF8 and Vacon 25, for example, both feature high conductivity which is closely linked to temperature. Vacon CF25 is also a sealing alloy which has proved effective in high-conductivity glass sealed power entry points in vacuum chambers.

This high-performance material replaces conventional copper wires and delivers far superior electrical and thermal conductivity.

Part of any high-quality mechanical clock or watch: mainspring of Nivaflex 45/5.



In Vacon CF8, the temperature-dependence of conductivity is exploited as an intrinsic control feature of the material. Used in wire assemblies connected to the heating element in diesel glow plugs, the material reduces heat-up time and automatically cuts the power when it reaches the target temperature; a “simple” wire thus eliminates the need for a complex electronic control unit. This custom alloy was thus the key to designing a competitive system that today leads the market. It is definitely true to say that advanced materials such as those developed by Vacuumschmelze are the key to progress.

Vacuumschmelze at wire 2010: hall 17, stand A 40.



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