VDM Metals

Materials for the

Electronics & Electrical Industries

Tough demands are our business

Founded in 1930, VDM Metals developed into a world market leader for high-performing metallic materials covering the wides product and service portfolio in the industry. The quality of our poducts and services bases on our integrated production chain in Germany and the United States and a sales network that spans the globe servicing the most demanding industries and backed by a strong R&D and Application Engineering force.

VDM Metals produces high-performance alloys for the use in extreme conditions. Our materials are made to last, resisting heavy mechanical and thermal stresses and corrosive environments, sometimes all three simultaneously.

Our materials represent technical advancement with a defined expansion behavior or an exact magnetic permeability, for example. In the electronic and electrical industries especially, our materials are essential thanks to their precisely configured properties.

Our nickel alloys as well as our high-alloyed special stainless steels are made from a wide spectrum of elements from the periodic table, because the solutions we develop are just as wide-ranging as the demands for which they are required.

Our materials are delivered as strip, wire, rod and bar, plate and sheet, forgings or welding consumables. Our processing plants and machinery are tailored to specific production requirements and local conditions and equipped with state-of-the-art process data acquisition systems, ensuring high productivity and production reliability. Our integrated manufacturing chain means that all major production steps are in our own hands – a vital prerequisite for a robust and stable production process. The result of our efforts: maximum purity, homogeneity, reproducibility and optimum processing characteristics of our products. Thus, our offering is nothing less than premium materials in any form needed as well as first class services, available anywhere in the world, specially tailored logistic solutions to the requirements of the electronics and electrical industries.

Focus on safety and reliability

Safety, reliability and durability are the cornerstones to any project in electrical engineering and implementation in the electronic industry. No matter whether you are active in producing automation systems, manufacturing highly demanding semi-conductor products or in driving forward the energy transition: VDM Metals is the ideal partner for demanding material concepts.

We perform extensive tests according to the respective customer specifications for physical and magnetic properties, corrosion or high-temperature requirements, as well as stability and expansion characteristics. Our comprehensive range of products is ever expanding, as we are continuously advancing our existing materials and develop new materials in collaboration with our customers to meet their special needs. An unbeatable argument.

Modern materials for the technologies of today and tomorrow

The challenge of digital transformation
Hardly any other technological development has changed everyday lives more than the electric industry, which came into being during the industrial revolution at the end of the 19th century. Electricity, electronics and electrical engineering are a self-evident and vital part of our life, and will grow even more important in the future. They are the factor with the greatest influence on how we live within a globalized society, drive digital transformation forward and are an enormous economic factor in an ever more networked and digital world.

Material engineering for future trends
A long service life and materials tailored to their exact application play a key role in component performance.

VDM Metals offers diverse solutions with its sustainable materials. Our products drive digital transformation and trend topics of the future forward: We not only offer solutions for the Industrial Internet of Things in areas such as sensor systems, performance electronics, systems engineering, controls for automation systems, but also for the energy transformation or industries such as medical technology.

Our customers expect materials that are tailored to their individual technical demands and fulfill the requirements for sustainable production along the entire value added chain. We take pioneering approaches to boost the performance of our products and incorporate them in new applications. By engineering new alloys, we help our customers to achieve their development goals. For example, modern OLED (organic light emitting diode) screens today use a material developed in the 50s with a defined expansion coefficient.

VDM Metals offers versatile material solutions with characteristics far superior to those of conventional stainless steels.

Strong materials for versatile applications


HOSPITAL
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Alloys for heating elements and resistance alloys

VDM Metals produces alloys for heating elements and resistance alloys in the form of strips and wires with various material compositions. Both material groups are characterized by relatively high or constant specific electrical resistance values, but both feature different heat resistances.

1 **Resistance alloys**

Developed in the 1950s by VDM Metals, Konstantan is a copper-nickel alloy that is still used to date. This resistance alloy is characterized by its defined electrical resistance and can be used in room temperatures of up to 500°C (932°F). It is used in the electrical and electronic industries as strips or wires, primarily as a component for electrical resistors for precision and measuring resistors in particular.

2 **Alloys for heating elements**

Alloys for heating elements transform electric current into heat. They are characterized by their high electrical resistance combined with scaling resistance and heat resistance, and are offered as wires or strips with varying alloy components for applications of up to 1,350°C (2462°F).

Application:

2a **Heating coils**

When used as heating coils, the heating elements are either wrapped around ceramic tubes or laid in grooved beds. If heating coils are not fixed with these ceramic tubes or grooved beds this requires a high material heat resistance in order to minimize sagging. In industrial applications, the coils are installed in continuous ovens for downstream processes in the metal industry. In the household sector, these heating wires are used in hair dryers, air conditioning units or clothes dryers.

2b **Tubular heating elements**

Alloys for heating elements are also used as tubular heating elements. The heating element is installed in a tube that provides electrical protection and isolates the heat conductor from liquids to be heated, for example. In industrial applications, tubular heating elements are used to heat solid, liquid or gaseous media. Examples include immersion baths in the food or pharma industries, drying furnaces as well as tooling, rolling or cleaning and degreasing systems in the heavy industry.

In the household sector, tubular heating elements are used in electric kettles, irons, waffle makers or ovens, as well as in ceramic cook tops as spiral-shaped strips in basic ceramic forms.

3 **Braking and starting resistors**

High-temperature alloys from VDM Metals are also used to design braking and starting resistors. They are electrical resistors that are switched on starting in order to limit the current to a permitted level and enable smooth starting. As braking resistors, they act as a consumer in the power circuit, absorbing the braking energy by converting it into heat.

Controlled expansion alloys and melting alloys

Nickel-iron alloys are materials with a defined expansive behavior.

4 **Controlled expansion alloys**

Controlled expansion alloys are characterized by very low expansion coefficients in a defined temperature range. In addition, they feature good ductility and toughness as well as a low fatigue at low temperatures. These alloys are used in a wide range of applications. For example, they are essential in industrial production, storage and transportation of liquefied gases, or as thermostat materials in measuring and control devices for temperatures below 200°C (392°F). In household electronics, they are important components in OLED screens.

5 **Melting alloys**

Based on their fixed expansion coefficients, melting alloys can be ideally adapted to the thermal expansion behavior of different types of glass and ceramics thanks to their alloy composition. These alloys are used in material combinations to seal high-quality electronic components or maintain a vacuum, for example.

These types of components are then used in the chemical industry in aggressive media in order to precisely measure temperatures, or in medical technology. In this area, sensitive components have to be protected against moisture during disinfection, sterilization and in autoclaves. Today, additional applications for solid and gas-tight connections between glass/ceramics and glass/metal can be seen in the electrical and electronic industries. VDM materials are also used in camera flashes, X-ray tubes or in CT equipment in medical technology, as well as in high-performance high-frequency tubes in radar and radio technology. Components made from these materials are also used in receiver tubes in solar power plants. Light bulbs, which are seeing an ever more negative trend and being replaced with LEDs and other light elements, are a typical example for the use of a glass-metal component.

For construction elements in semiconductor technology, such as telecommunications, power electronics and computer systems, they are an essential component. Reed relays are often used in automation technology in pneumatic cylinders or measuring devices. In the chemical industry, these components are the preferred choice due to their encapsulation.

Soft magnetic alloys

Soft magnetic materials are characterized by high magnetic conductivity (permeability) and have a long application tradition in electrical engineering. The nickel-iron alloys group with a high nickel content, which contains the VDM® MAG 75 and VDM® MAG 7904, is characterized by a high permeability and low coercive force. VDM® MAG 50 and VDM® MAG 53, with a nickel content of 50 percent, are both part of a maximum saturation polarization range, but have lower permeabilities.

6a

Electromagnetic components

VDM Metals has been producing soft magnetic alloys for a wide range of applications for many years, including toroidal cores, transducers, transformers and as yokes and armatures of relays. In addition, these materials are used in a wide range of different components for electrical technology, for example in motors and generators, in power adapters for electronic devices and in transformers.

The best known example is likely the residual-current device (RCD), which can be found in every home ensuring safe electrical and power circuits. Residual-current devices prevent dangerous high residual currents in power networks, thus preventing electric shock. As a circuit breaker, it switches off the power circuit when a set residual current intensity has been reached. Today, these RCDs have been replaced with components made of nanocrystals.

This material is also used in safety valves in gas boilers and gas stoves. Gas safety valves are thermoelectrical safety pilots that immediately stop unburned gas from leaking in the event of a malfunction. Soft magnetic materials from VDM are also used in this area.

6b

Shielding alloy

These materials are also used in the area of shielding. Here, they serve as shields for electromagnetic fields, for example, to limit or prevent resulting interference entirely. This is necessary in industrial applications, for example, or in MRI scanners in the medical sector. These materials are even used in the entertainment industry to reduce or completely block out electromagnetic interference, and they are also installed in transformers for shielding.

Energy

In the area of energy technology, VDM Metals offers solutions for current and future problems in energy supply with various materials.

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Electrical technology: Overhead power lines

Wind parks located in the North Sea generate electricity that has to be transported across long distances. The existing overhead power lines are not sufficient to do this, so new high-voltage transmissions lines have to be laid. Higher amounts of electricity cause the lines to heat up and sag. VDM Metals has developed a material for these higher capacities that prevents sagging, even with higher amounts of electricity. Thanks to VDM® Alloy 36 Powerline, existing power lines can be retrofitted, meaning no new installations are required. On the other hand, the solution makes new power lines even more efficient, equipping them for future demands.

8

Superconductors

High temperature superconductors enable electricity to be transported without resistance, as well as fast short-circuit limiters and transformers with very high degrees of efficiency. The non-magnetic material VDM® Alloy C-276 is used as a substrate film for second generation high temperature superconductors, including nickel-tungsten alloys such as VDM® Supratex 5 and VDM® Supratex 9.

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Household applications: Solid oxide fuel cells (SOFC) and solid oxide electrolytic cells (SOEC)

The energy supply of tomorrow has to be as environmentally and resource-friendly as possible. Solid oxide fuel cells are a high temperature fuel cell variant with a very high degree of electrical efficiency. In industrial applications, they are used as cogeneration systems, but can also be used in supplying energy to private households. They can be operated with different media, such as hydrogen. In collaboration with research center Jülich, VDM Metals has developed two materials for advancing SOFC fuel cells. For more efficient application and building higher voltages, multiple fuel cells are connected in series. The individual fuel cells are connected with a conductive interconnector plate that provides the required mechanical stability. Both materials form a conductive oxide layer on the surface. This minimizes the contact resistance between the individual cells in the fuel cell stack and optimizes system performance.

The fuel cell is used as a solid oxide electrolytic cell (SOEC) to convert electrical energy into chemical energy, as well as liquid and gaseous fuels. When high amounts of solar or wind power are generated, the electrolyzer then transforms excessive energy into gas, which can later be used to stabilize the network during power production.

Today, it's difficult to imagine life without a refrigerator or electrical light, without cellphones or computers. Electronics and the electrical industry characterize our everyday life like no other sector. Modern industrial production especially wouldn't be what it is today without electronics and products from the electrical industry. Without electrical drives, automation systems and control technology, industrial mass production, now characterized by speed, flexibility and precision, would not be possible.

Electronic components can be found in virtually every technical product. They begin with complex base materials, which are transformed into components using suitable mounting and connection technologies, then to modules and finally combined into entire systems. Key demands include energy efficiency, durability and resistance to the effects of aging.
Renewable energies are also playing an ever more important role. Feeding generated electricity back into the network presents the power grid and its controls with new challenges in particular.

With its materials, characterized by their versatile properties, VDM Metals plays an important role in many applications in the electronic, electrical engineering and renewable energy industries.

Alloys and applications

Special alloys

Designation	DIN EN	UNS	Typical chemical composition, in %	Application	Product form				
					Strip	Wire	Bar	Billet	Plate
VDM® Alloy 212	2.4110	N02212	Ni-1,6Mn	Electrode contacts and electrical lead wires		•			
VDM® Alloy 301	–	N03301	Ni-4Al-0,4Ti	Conductive springs		•			
VDM Crofer 22 APU®	1.4760	S44535	Fe-22,5Cr-0,1La	SOFC	•				•
VDM® Crofer 22 H	1.4755	S44537	Fe-22,5Cr-2W-0,5Nb-0,1La	SOFC	•	(•)	(•)	(•)	•

Controlled expansion alloys

Designation	DIN EN	UNS	Typical chemical composition, in %	Application	Product form				
					Strip	Wire	Bar	Billet	Plate
VDM® Alloy 20-6	1.3932	–	Fe-20Ni-6Mn	Thermal bimetals	•				
VDM® Alloy 22-3	1.3942	–	Fe-22Ni-3Cr	Thermal bimetals	•				
VDM® Alloy 29-18	1.3981	K94610	Fe-29,6Ni-16,9Co	Hard glass blends, TO packages, shape-etched parts, X-ray tubes, connecting wires, receiver tubes for solar power plants	•	•	•	•	•
VDM® Alloy 36	1.3912	K93603, K93600	Fe-36Ni	OLED screens, thermostats, bimetal components, electronic control units for satellites and space, pendulums	•	•	•	•	•
VDM® Alloy 36 Powerline	–	–	Fe-36Ni-2,5Mo-0,9Cr-0,5W	High voltage lines		•			
VDM® Alloy 42	1.3917	K94100	Fe-41Ni	Thermal bimetals, pressed glass blends, X-ray tubes	•	(•)	(•)		
VDM® Alloy 47-6	2.4486	–	Ni-46Fe-6Cr	Glass blends (soft glass)	(•)	•			
VDM® Alloy 51	2.4475	N14052	Ni-49Fe	Glass blends, reed relays	•	(•)			
VDM® Alloy 52	2.4478	N14052	Ni-49Fe	Glass blends, reed relays	•	•	(•)		
VDM® Alloy 55	2.4472	–	Ni-44Fe	Glass blends		(•)			
VDM® Alloy 902	1.3918	N09902	Fe-42,5Ni-5Cr-2Ti	Weighing mechanisms	(•)		•		
VDM® Ni 42	1.3917	K94200	Fe-42Ni	Mechanical filters	•	•	•		
VDM® Ni 42 Ti	(1.3917)	(K94200)	Fe-41,5Ni-0,2Ti	Thermal bimetals, pressed glass	•				

Soft magnetic alloys

Designation	DIN EN	UNS	Typical chemical composition, in %	Application	Product form				
					Strip	Wire	Bar	Billet	Plate
VDM® MAG 36	1.3910	K93600	Fe-36Ni	Shielding alloy	•	•	•	•	(•)
VDM® MAG 50	1.3922, 1.3927	K94840	Fe-48Ni	LF power transformers, rotor and stator cores, throttles, relay parts, toroidal transformers, step motors, solenoid valves, shielding elements	•	•			
VDM® MAG 53	2.4420	–	Ni-44Fe	Transducers, transformers, residual-current devices, toroidal cores for special applications	•				
VDM® MAG 75	2.4501	N14076	Ni-16Fe-5Cu-2Cr	Transducers, transformers, residual-current devices, toroidal cores for special applications	•				

• Available product forms. (•) Please contact us with respect to availability.

Soft magnetic alloys

Designation	DIN EN	UNS	Typical chemical composition, in %	Application	Product form				
					Strip	Wire	Bar	Billet	Plate
VDM® MAG 7904	2.4545	N14080	Ni-14Fe-5Mo	Toroidal core power transformers, measuring transformers, inductive elements, lamination transformer cores, shielding elements as film, housing and room shielding against magnetic interference, step motors/resolver stamped parts, molded relay parts for electromagnetic relays, other solid parts with low coercivity	•	(•)			•

Heating element and resistance alloys

Designation	DIN EN	UNS	Typical chemical composition, in %	Application	Product form				
					Strip	Wire	Bar	Billet	Plate
VDM® Alloy 40 B	1.4888	–	Fe-37,5Ni-21Cr-1,6Si-0,1La	Heating coils for use in industrial ovens and household devices	•	•			
VDM® Alloy HT 30	1.4860	–	Fe-30Ni-20Cr-2,5Si	For use as tubular heating elements and in industrial ovens as heating coils, braking resistors	•	•			
VDM® Alloy HT 60	2.4867	N06004	Ni-21Fe-15Cr-1,3Si	Application as heating coils, for example in industrial ovens, in tubular heating elements and as braking resistors	•	•			
VDM® Alloy HT 70	2.4658	N06008	Ni-30Cr-1,2Si	Application in industrial ovens	•	•			
VDM® Alloy HT 80	2.4869	N06003	Ni-20Cr-1,2Si	Application in industrial ovens	•	•	(•)		•
VDM® Alloy HT 90	(2.4999)	(N06010)	Ni-9,5Cr	Thermal element	•				
VDM Konstantan®	2.0842	C72150	Cu-44,5Ni-1Mn	Resistance alloy. Use as a component for electrical resistors, measuring resistors and potentiometers	•	•			
VDM® Aluchrom 0	1.4765	K92500	Fe-22Cr-5,2Al-0,2Zr	Industrial ovens and radiant burners		•			
VDM® Aluchrom I	1.4767	K92400	Fe-20Cr-5Al-0,2Zr	Industrial ovens and radiant burners		•			
VDM® Aluchrom W	1.4725	K91670	Fe-14,8Cr-4,6Al-0,15Zr	Braking and starting resistors	•	•			
VDM® Aluchrom Y Hf	1.4767	K92500	Fe-20,5Cr-0,05Y-0,05Hf	Ceramic cook tops	•				
VDM® Aluchrom 520 Y Hf	1.4767	–	Fe-20,5Cr-5,2Al-0,05Y-0,04Hf	Ceramic cook tops	•				

High-temperature alloys

Designation	DIN EN	UNS	Typical chemical composition, in %	Application	Product form				
					Strip	Wire	Bar	Billet	Plate
VDM® Alloy 601	2.4851	N06601	Ni-23Cr-14Fe-1,4Al	Breaking resistors	•	•	•	•	•
VDM® Alloy 800	1.4876	N08800	Fe-30,5Ni-20,5Cr-max.0,7Al+Ti	Tubular heating elements/calrod, breaking resistors	•	•	•	•	•
VDM® Alloy 840	1.4847	–	Fe-20Ni-20Cr	Tubular heating elements/calrod	•				

Corrosion resistant alloys

Designation	DIN EN	UNS	Typical chemical composition, in %	Application	Product form				
					Strip	Wire	Bar	Billet	Plate
VDM® Alloy 825	2.4858	N08825	Ni-30Fe-23Cr-3Mo-2Cu-0,9Ti	Tubular heating elements/calrod	•	•	•	•	•
VDM® Alloy C-276	2.4819	N10276	Ni-5Fe-16Cr-16Mo-4W	Substrate for superconductors	•	•	•	•	•

• Available product forms. **(•) Please contact us with respect to availability.**

Integrated production

Projects and production in the electronics and electrical industry are characterized by high standards in terms of product safety, reliability and longevity, requiring partners with know-how and expertise. VDM Metals has more than 85 years of experience in designing and producing materials of the highest quality standards. The company operates production sites in Germany and the United States, covering the majority of important production steps - from melting to hot-forming to cold-forming.

Melting and casting
VDM Metals' nickel alloys and special stainless steels are melted in an electric arc furnace or an induction furnace and then subjected to vacuum treatment. A ladle furnace is available for secondary metallurgical treatment. Casting takes place in a vertical continuous caster or by ingot casting. In addition to the conventional technology of open melting, VDM Metals uses the technology of vacuum induction melting (VIM). The homogeneity and purity of our materials can be enhanced by electroslag (ESR) or vacuum arc remelting (VAR).

The cast and/or remelted slabs and ingots serve VDM Metals as starting material for the production of sheet and plate, strip, bars and rods, welding consumables and wire.

Strips
Strip is cold rolled on four-high and Sendzimir mills. Foil can be rolled down to a thickness of 0.001 in (0.025 mm) on a special 20-high mill. Annealing, levelling and cutting equipment is available for finishing operations to meet customer specifications.

Wires and welding consumables
VDM Metals produces wire in fine and ultra-fine gauges down to a diameter of 0.004 in (0.1 mm), heavy gauge and section wire as well as welding wire.

Rods and bars
For the production of forged bars with a diameter of more than 4.72 in (120 mm) and semi-finished products, state-of-the-art turning lathes, peeling and grinding machines are available. The production of hot-rolled and forged bars with a diameter of less than 4.72 in (120 mm) is performed with modern peeling and grinding machines. A 60-ton drawing bench is available for the manufacture of cold-drawn precision bars. VDM Metals' finishing plants are equipped with heat treatment furnaces, pickling, shot blasting and cutting units.

Sheets and Plates
Sheet and plate in thicknesses of 0.12 to 3.93 in (3 to 100 mm) are hot rolled on a four-high mill, before finishing steps such as annealing, grinding, shot blasting, pickling and cutting take place. VDM Metals operates a Sendzimir reversing mill that can process hot-rolled sheet to cold-rolled sheet in widths of up to 98.42 in (2,500 mm) and a thickness of up to 0.04 in (1 mm).

Forgings
VDM Metals operates one of the most modern free form forges of anywhere in the world. The forge press operates with a pressure of up to 4,500 tons and has two rail-bound manipulators. The press receives its feedstock from dedicated heating and reheating furnaces.


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Comprehensive customer support

Customer relationships with VDM Metals mean access to a wide variety of comprehensive services - "services that really make the difference."

Technical customer support
From selecting the right materials to any request on specifications, properties and fabrication characteristics – VDM Metals' Application Engineering team will be more than happy to provide you with prompt answers and support, relying on their technical and metallurgical background and experience in all fabrication matters of VDM's materials.

Material and corrosion tests
Quality is a top priority at VDM Metals. In addition to the approvals for individual plants, all quality management systems of the different VDM Metals locations are certified according to ISO 9001 and AS 9100. Extensive product tests and examinations are carried out in our on-site laboratories. This includes our metallography, our spectral laboratory, our chemical laboratory, our corrosion laboratory or our mechanical laboratory.

Research and Development (R&D)
The performance of our materials depends decisively on their chemical composition. This may be surprisingly simple or highly complex, but in every case it is the result of intensive R&D work. We not only develop new materials, but also sound out hidden performance potential in market-proven alloys, which we can then qualify for new applications. Our R&D experts accompany the projects, sometimes right up to commissioning and start-up. The solutions that evolve find their way into new products, as well as techniques and processes.

Individual solutions for electronics and electrical industries
VDM Metals adjusted to the special demands of the worldwide electronics and electrical industries. Together with our customers, we develop solutions for their specific needs. In doing so, we are able to meet the different requirements regarding just-in-time production, reliability and delivery times - worldwide.

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