

VDM® Alloy C-264: VDM Metals develops new high-temperature material for turbochargers

Werdohl. With VDM® Alloy C-264, VDM Metals has launched a new nickel-based alloy with excellent strength and creep properties for use in a temperature range up to 900 °C. Applications for the new material, available as strip, include ultra-efficient turbochargers.

Headquartered in Werdohl, the VDM Metals Group has long produced strips and sheets of nickel-based alloys that are used for heat shields in turbochargers. Depending on the material used, application temperatures were limited to about 800 °C, putting a damper on turbocharger efficiency. "With most of the materials used to date, the γ' phase, which is responsible for the strength of the material among other things, is instable at temperatures over 800 °C. This means that the component can be deformed permanently, possibly causing it to fail. The objective in developing the material was to achieve better stability in the γ' phase at higher temperatures while suppressing the adverse η phase," explains Dr. Jürgen Kiese, Material Engineer at VDM Metals. After around two years of development, VDM Metals can now present VDM® Alloy C-264, a material that features crucial advantages over previous alloys in terms of application temperatures and component service life.

Optimized chemical analysis

First, the new material was optimized in terms of analysis. "Besides the main alloy element of nickel, the new alloy contains 25 percent chrome, 20 percent cobalt and approximately 5.5 percent molybdenum. Adding aluminum and titanium in the order of 1.1 and 1.7 percent respectively ensures the new material has an excellent strength at high temperatures," explains Dr. Kiese. Later on in production, the material is solution-annealed and generally age-hardened on the finished component. This annealing process is carried out to solubilize all elements required for precipitation hardening. After cooling down, the desired hardening structure can be reached by means of precipitation hardening. "In various tests, we were able to show that the new material in its solution-annealed and age-hardened state achieves higher hardening values at temperatures between 850 °C and 900 °C than Alloy C-263, for example," says Dr. Kiese.

Creep properties enable applications at 900 °C

As the requirements for the new alloy included not only high strength but also creep resistance, various creep tests were performed during development. "Creeping refers to the time-dependent, progressive plastic deformation of a material under constant strain. To be able to provide information on the service life of specific components, the material has to be subjected to creep rupture tests under as realistic conditions as possible," explains Frank Scheide, Application Engineer in the Automotive unit. In testing the new material, the defined parameters included a temperature of 900 °C and a pressure of 70 MPa. The result: This test series showed much lower creep rates, outperforming material C-263. "In terms of creep resistance, we achieve a service life a good 10 times longer than known materials used to date. Even temporary thermal load peaks are no problem for the material, as the η phase is suppressed and the γ' phase is recovered after cooling down, kind of like a self-healing process," states Mr. Scheide in summary.

Cold rolled strips and other semi-finished forms

The new material also features good machining properties according to Dr. Kiese. "For turbocharger applications, we provide the material in strip form. Cold rolled products can be manufactured in thicknesses ranging from 0.15 millimeters to 3.00 millimeters," states Dr. Kiese. Material experts at VDM Metals all agree: VDM® Alloy C-264 offers major potential for developing more efficient turbochargers and beyond. And by the way: Other semi-finished forms (rods, billets, sheets, wires) are also conceivable.

Additional information

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About VDM Metals

The VDM Metals Group, based in Werdohl, develops and manufactures nickel, cobalt and zirconium alloys as well as high-alloyed special stainless steels. For over 85 years, the company has been supplying sheet metal, strips, rods, wires and welding fillers to customers in the chemical industry, plant construction, energy generation, oil and gas, electrical and electronics, as well as automotive and aerospace industries. In fiscal year 2016/17, the company with around 1,900 employees achieved a total turnover of 875 million euros, producing 37,300 tons of semi-finished products and metals.

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