TECHNOLOGICAL SEMINAR OF DELORO STELLITE IN ZAPOROZHIE

Technological Seminar «Peculiarities of Application of Deloro Stellite Equipment and Materials in Aerospace Engineering and Turbine Construction» took place in Zaporozhie, Ukraine. It was organized by specialists of Deloro Stellite (Germany) and OJSC Motor Sich (Ukraine). Specialists of Deloro Stellite and Motor Sich, as well as 46 specialists representing aircraft repair and machine building enterprises of Ukraine, Russia and Belarus took part in the Seminar.

The Seminar was opened at the conference-hall of the «Dion» hotel on November 23 with presentation of a group of the Deloro Stellite companies made by E.M. Dubunina, manager of Deloro Stellite in CIS. It was noted that Deloro Stellite is a leading company having world name, centennial history and wide experience in the field of manufacture of parts from cobalt, nickel and iron based alloys: filler materials for cladding and spraying in the form of rods, electrodes, flux-cored wires and powders, cast parts and parts produced by powder metallurgy using customers' drawings, as well as equipment for plasma-powder cladding (PTA) and supersonic spraying (Jet Kote). The group of Deloro Stellite companies consists of 14 plants in Germany, Italy, France, England, India, USA, China, Canada and Russia, the headquarters being located in Koblenz (Germany).

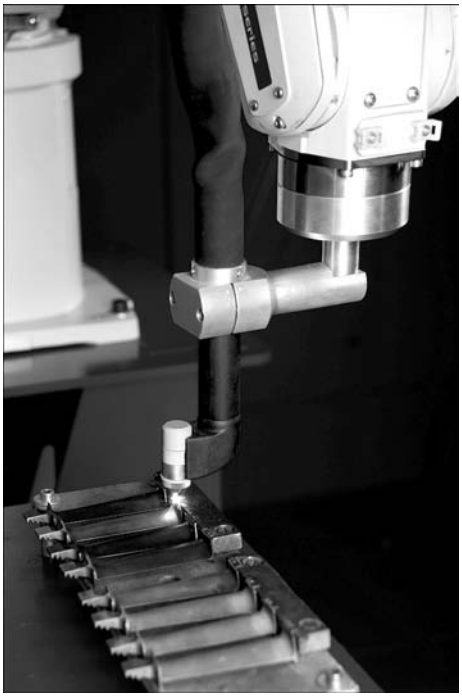
Activities of Deloro Stellite are oriented to protection of surfaces of super heavy-duty metallic parts from complex wear. Alloys of the Company work well under severe conditions of the influence by several wear factors at a time, for example, high temperature and impact loads, corrosion, abrasive wear, cavitations and etc.

Repair and strengthening technologies of Deloro Stellite took firm positions in different industries from airspace engineering, power generation, automotive industry, nuclear power engineering, oil and gas production and chemical engineering to medicine, etc.

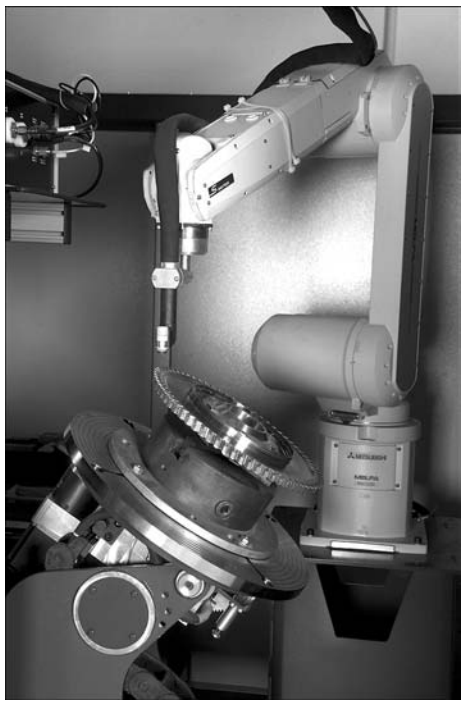
Aviation, cosmonautics and turbine construction are special industries, where, as a rule, the latest achievements in materials science, application of high technologies and modern equipment are concentrated. Being a world leader in the field of the improvement of wear resistance, Deloro Stellite gives special consideration to the industries where wear protection, service life and operational reliability of equipment are tightly interrelated.

Deloro Stellite offers a wide range of wear-, heat- and corrosion-resistant alloys. The Company has in its arsenal more than 500 alloys developed to address specific technical tasks. Properties of such alloys are determined by the hard phase of carbides, intermetallics, borides and other materials contained in a tough metal matrix.

The most widespread and extensively used are cobalt-based alloys of the Stellite® series, belonging to the Co–Cr–W–C group. These alloys retain their very high abrasive and corrosion resistance at elevated tem-



Robotic microplasma cladding of blades at «Motor Sich»



Robotic microplasma cladding of labyrinth disk at «Motor Sich»

Cladding of labyrinth disk

Weld beads on labyrinth disk

peratures and have excellent cavitation and erosion resistance, as well as high score resistance.

Deloro® series nickel-based alloys of the Ni–Cr–B–Si type provide good corrosion and abrasive wear resistance, and retain hardness at high temperatures, which in some cases allows using them instead of the Stellite® ones. These alloys are widely used for surfacing of industrial valves and elements of stop valves.

Tribaloy®, Stellite®, Deloro®, Nistelle®, Stelcar®, Jet Kote® and Delchrome® are covered by patents, and are the registered trade marks of Deloro Stellite. The Tribaloy® series cobalt-based alloys of intermetallic type contain the hard Laves phase distributed in a softer matrix of the eutectoid or solid solution type. These alloys are widely used in cases where dry metal to metal friction is combined with high temperature, corrosion and abrasive wear. The area of application is continually widening (automotive, aerospace, shipbuilding, etc.).

Nistelle® are nickel-based alloys developed for protection of surfaces from aggressive chemical environments. They also have high resistance to thermal and mechanical impacts.

Stelcar® type alloys are a mixture of carbide particles and self-fluxing nickel or cobalt powder. Because of their specific compositions, these materials are produced only in the form of composite powders for cladding and spraying.

Jet Kote® powders are applied for supersonic thermal spraying and produced in different combinations of mixtures of agglomerated and spheroidized powders, e.g. WC–Co, Cr_3C_2–NiCr, or of Stellite® and Deloro® alloys.

Delchrome® alloys are iron-based alloys. They are developed for cladding of parts working under abrasive wear conditions at low temperatures. Their corrosion resistance is relatively low, compared to cobalt and nickel alloys.

The Table gives generalized data for selection of one or other Deloro Stellite material, depending on the service conditions.

The experience accumulated by Deloro Stellite allows solving the problems of clients by selecting the required alloy or developing the new one for specific service conditions at a customer's request. For this the Company can offer manufacture of parts by the precision casting method, or it can offer a welding consumable (electrode, wire, rod, powder), necessary equipment and repair technology.

Deloro Stellite materials are used in repair and strengthening technologies by using the following methods:

- argon-arc/acetylene-oxygen cladding with rods;
- manual arc covered-electrode cladding;
- mechanized shielded-gas flux-cored wire arc cladding (MIG/MAG), submerged-arc cladding;
- plasma-powder cladding;
- laser cladding;
- flame spraying with further fusion;
- flame powder cladding;
- plasma spraying;
- supersonic flame spraying (HVOF, Jet Kote).

Selection of alloy	Alloy	Wear		
		Mechanical	Corrosion	High temperature
Low resistance +	Stellite	+++	+++	++++
	Deloro	+++	+	+
Satisfactory resistance ++	Tribaloy	+++	+++	++++
Good resistance +++	Nistelle	+	++++	+
	Delchrome	+++	+	+

The most efficient repair and strengthening technologies are based on utilization of plasma-powder cladding, i.e. PTA process, and supersonic spraying (Jet Kote).

The equipment for cladding and spraying, developed by Deloro Stellite, has a modular structure, which allows the required layout to be performed to address various practical tasks and meet requirements of a customer. For example, the robotic PTA unit for Motor Sich has the following technical capabilities and specifications:

- weld bead width — 1.2–5.0 mm;
- minimum thickness of a part — 0.8 mm;
- consistent weld bead size;
- automatic positioning of plasmatron;
- program control of all cladding parameters;
- two working positions for cladding;
- mains voltage — 3 × 400 V;
- welding current — 3–190 A;
- pilot arc current — 3–30 A;
- carrier gas flow rate — 0.5–5.0 l/min;
- shielding gas flow rate — 1.5–15.0 l/min;
- plasma gas flow rate — 0.2–5.0 l/min.

Units for supersonic spraying (Jet Kote) provide the process with minimum heating of a workpiece (cold hardening).

Utilization of agglomerated and spheroidized Deloro Stellite powders with a small amount of stellites allows achieving a high density of the surface with only 1–2 % porosity, the process characteristics being as follows:

- gas plasma jet velocity — 1500–2000 m/s;
- plasma temperature — 2700–3000 °C;
- powder particles flying velocity — 900–1200 m/s;
- spraying rate — 2–6 kg/h;
- flow rates of gases: natural gas — 100–150 l/min; oxygen — 220–330 l/min; nitrogen, argon — 25–40 l/min.

The latest supersonic spraying (HVOF) unit is operated at the venture company of Deloro Stellite and Russian partners — DS URAL Perm. The unit is robotized, having a capability of spraying of parts up to 10 m long and up to 4 t in weight.

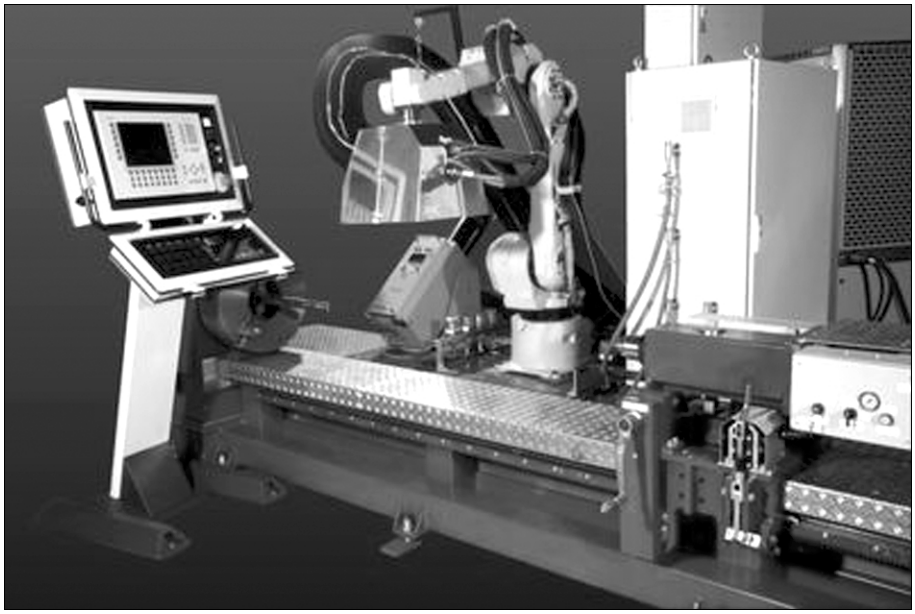
Deloro Stellite continuously improves its products. New grades of alloys are developed, widening the technological capabilities of reconditioning of parts. This fact was told about at the Seminar by Prof. A. Pavlenko, manager of export to Europe and South-East Asia countries.

The Company offered a new process — high-temperature isostatic pressing, including heating of a cast part from the Deloro Stellite material up to a melting temperature and holding it under a super high pressure in a neutral medium. This treatment removes casting microdefects and consolidates the material, imparting it new characteristics.

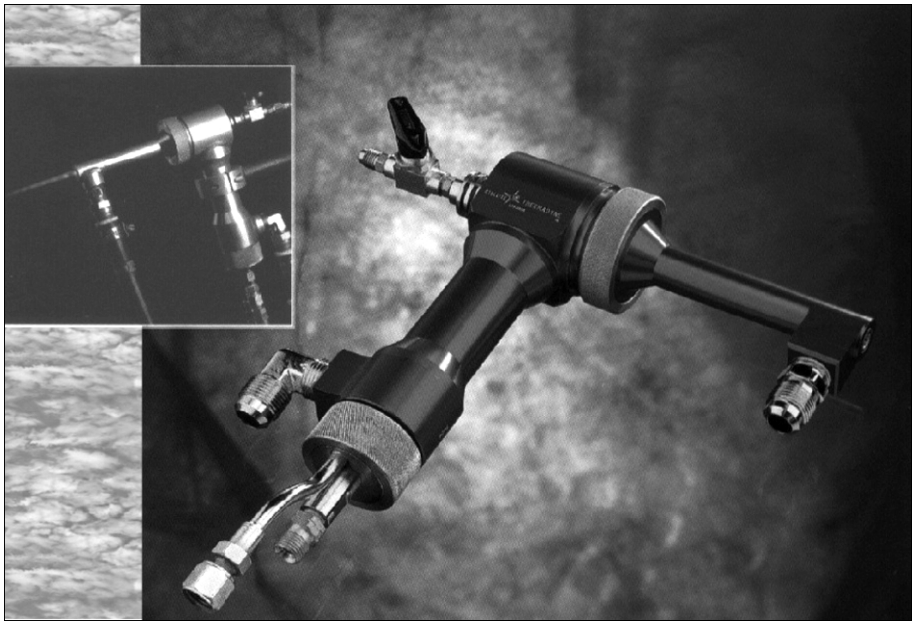
700 series of Stellite alloy, doped with molybdenum instead of tungsten, was developed. It results in a higher wear resistance and corrosion resistance without reduction of hot hardness.

The Seminar was continued on November 24 at the Motor Sich Zaporozhsky plant, which was founded in 1907 and is today one of the world-biggest plants manufacturing aircraft engines. Motor Sich engines are operated in more than 100 countries of the world; every tenth aircraft and every fourth helicopter in the world is equipped with the Motor Sich engines. Products of the plant are certified by Bureau Veritas ISO 9001–2000.

Units with specific characteristics to address the problems of repair and strengthening of super thin and small parts in aerospace engineering and power generation were developed in 2007 after four years of scientific-and-technical cooperation of the specialists of Motor Sich and Deloro Stellite. In the same year, the units were supplied to a customer, and a section



Jet Kote unit for supersonic spraying



Gun for supersonic spraying

for repair of blades and disks of gas turbine engines was arranged at the plant.

Earlier, the blades were repaired at the plant by manual argon arc cladding using rods. According to I.A. Petrik, Chief Welder of Motor Sich, it took a week to clad one disk by the manual argon arc method at a rather low quality, up to 20 % of clad products were rejected (cracks, etc.). A change of the repair technology from manual argon-arc to plasma-powder allowed improving the quality and efficiency of repair. The units were repaid for two years. At present, domestic powders JS-32 and JS-6 produced by UkrNII-SpetsStal (Zaporozhie), as well as powders V3K and Stellite® produced by Deloro Stellite are used for plasma-powder cladding. The experience of utilization of the above powders showed their high quality. I.A. Petrik indicated the following advantages of the plasma-powder cladding process: low base metal with cladding alloy dilution, low temperature distortions of workpieces, decrease in the amount of machining after cladding, reduction of losses of filler powder, high repeatability of the cladding process, and easy automation. Some disadvantages were also noted: difficulties in using some types of powder in one work shift, as it is necessary to refill the powder feeder, which increases downtime of the equipment; cladding can be well performed on edges and worse — on plane surfaces; it is better to perform cladding in a vertical position.

Answering questions asked by the Seminar participants, E.M. Dubunina informed, in particular, that the Deloro Stellite PTA units can be equipped with the two feeders for different powders, which can significantly speed up changing of the powders; the angle of inclination of the plasmatron from a vertical line can be changed up to 45° and more; and cladding, if necessary, can be performed in the overhead position.

A storehouse of Deloro Stellite for direct sales to clients in the CIS countries was opened in Moscow in October 2009. GRIK Ltd. (Kiev), being a representative of Deloro Stellite in Ukraine for 10 years now, sells the Deloro Stellite goods in Ukraine.

In conclusion, participants of the Seminar pointed out that advanced technologies of Deloro Stellite can well address the problems of manufacture and repair of parts for aircraft engineering and turbine building, providing good technical and technological characteristics, and proved expediency of application of the Deloro Stellite equipment at enterprises of the aircraft and power generation complexes of Ukraine, Russia and Belarus.

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Prof. V.N. Lipodaev, PWI