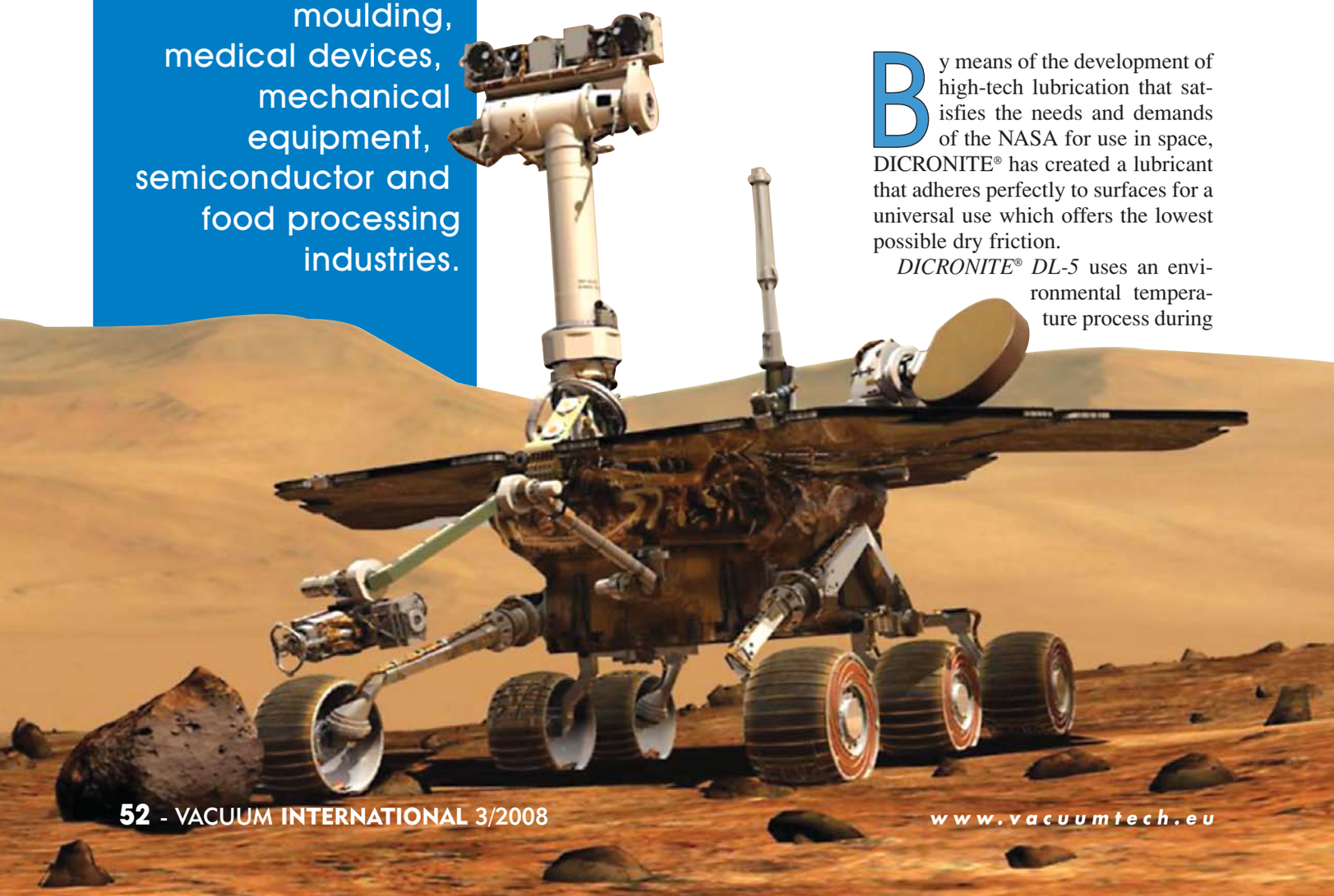
From the Mars Rover to vacuum applications

Developed as part of NASA's space exploration programme, Dicronite dry lubrication is the trusted dry lubrication technology for the aerospace, vacuum applications, plastics moulding, medical devices, mechanical equipment, semiconductor and food processing industries.

By means of the development of high-tech lubrication that satisfies the needs and demands of the NASA for use in space, DICRONITE® has created a lubricant that adheres perfectly to surfaces for a universal use which offers the lowest possible dry friction.

DICRONITE® DL-5 uses an environmental temperature process during



which, molecules are planted into the surface at high speed.

In order to guarantee molecular anchorage, Dicronite treats the surface to obtain an atomic structure that is without oxidises and impurities. DISOLFURO DI WOLFRAMIO (WS2) becomes an integral part of the support material and can be removed by abrasively removing the substrate.

Key to Dicronite dry lubrication's wide range of application are its:

- -ultra low coefficient of friction (μ=0.030) against itself;
- -precision film thickness of 0.5 micron maximum on any metal;
- -wide functional temperature span: -188°C to +538°C (up to 1316°C in vacuum;
- -near ambient temperature (max35°C) application process.

Based on these key values, Dicronite dry lubrication is proven for:

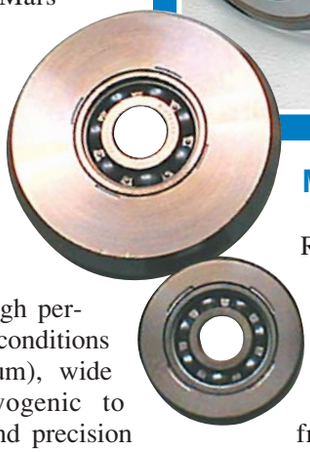
- -friction and wear reduction -anti seize/anti galling;
- -in place of conventional lubricants in high-vacuum and extreme temperature situations.

APPLICATION IN SPACE

Dicronite dry lubrication's low outgassing, precision tolerance and functionality under wide temperature and vacuum ranges have lead to its widespread use in space applications and UHV. In fact, the Mars Rover Explorer and the US Space Shuttle rely on Dicronite dry lubrication for sliding and rotational components.

In ground based space exploration, the Max Planck Institute's infra-red detectors rely on Dicronite dry lubrication for the linear and rotational actuators operating at cryogenic temperatures:

- -instrumental deployment device lubrication on the Mars Explorer Rover;
- -precision roller bearings in satellites;
- -linear and rotational cryogenic actuators in infrared detectors.



VACUUM ENVIRONMENTS

Widely used for its high performance under vacuum conditions ("μ" stable under vacuum), wide temperature range (cryogenic to 1316°C at 10-14 torr) and precision thickness (0.5 μ maximum), Dicronite is the vacuum equipment industry's top dry lubrication technology.

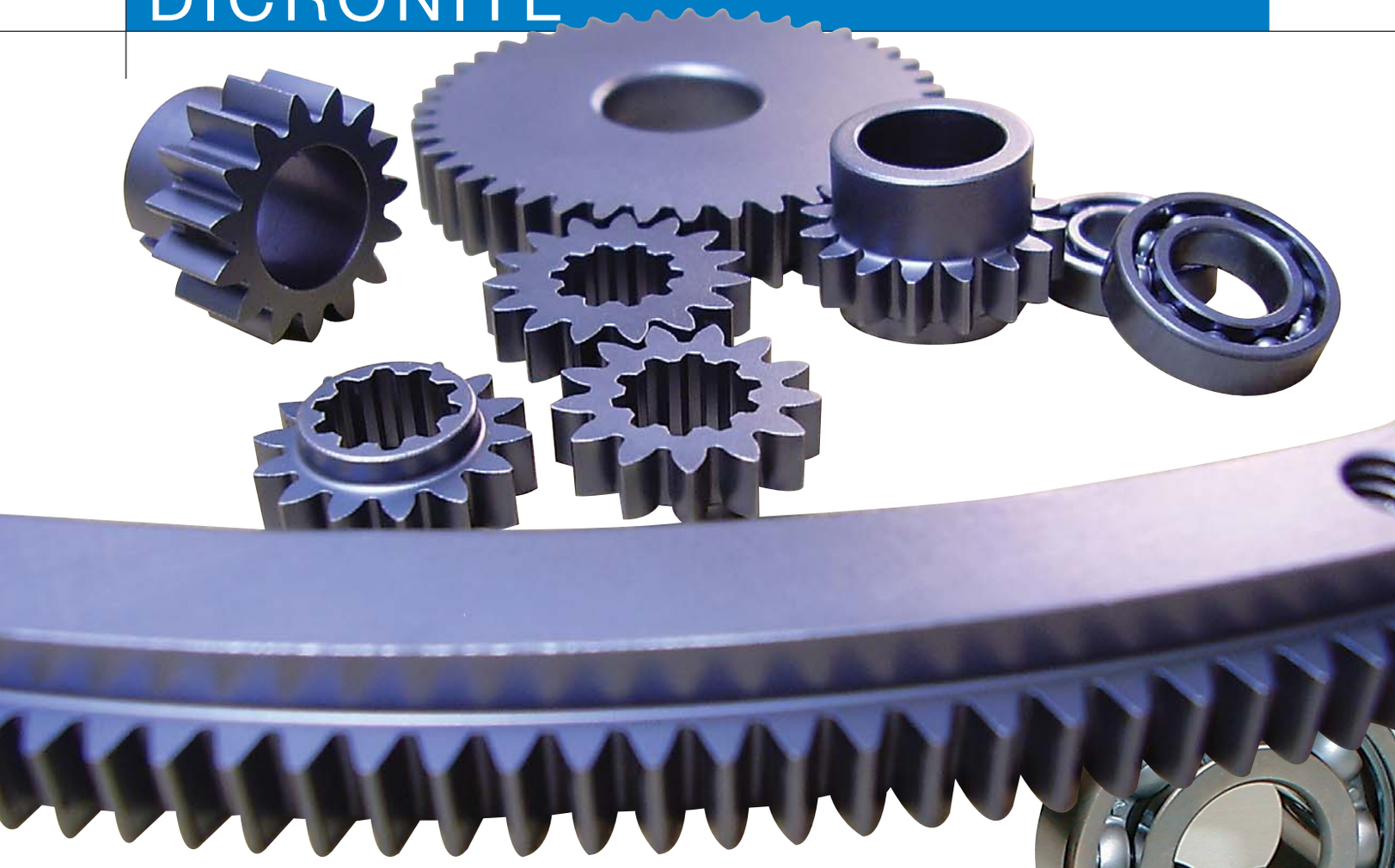
Companys including NASA, General Dynamics and Lochheed rely on Dicronite dry lubrication for:

- -vacuum pump bearing lubrication;
- -linear and rotational motion devices in satellites and space vehicles;
- -lubrication and fretting reduction - titanium, aluminium and stainless electron microscope components;
- -actuators and valves;
- -standard parts: gears and mounted bearings.

MARS LORER ROVER

The Mars Explorer Rover (MER° programme's two rover - Spirit and Opportunity - were equipped for their January 2004 launch with a five degree-of-freedom, 1-meter long robotic arm known as the Instrumental Deployment Device (IDD). The IDD positions instruments mounted to its end effector with greater precision than any previous Martian arm. Two dual-use caging mechanisms were designed for the IDD. The mechanisms are very small in size and act as launch restraints, as well as passive cradling (re-stowing) features during rover excursions on the Martian surface. A mechanism was needed to protect IDD during launch, travel and landing and release the IDD when required on the planetary surface.

DICRONITE



Key design parameters included wide temperature ranges (-120°C to 110°C survival/-120°C to +45°C operational), and lowest possible mass and volume. The resulting design relied upon pins engaging bushings, where the pin ends were radiused to mimic spherical bearings since spherical bearings could not be used due to height limitations.

Initially no lubrication was specified; however upon assembly, the sliding friction of the pins through the bushings was assessed to be high. A wet lubricant was not used because low viscosity at the -120°C operational temperature could hinder latch release.

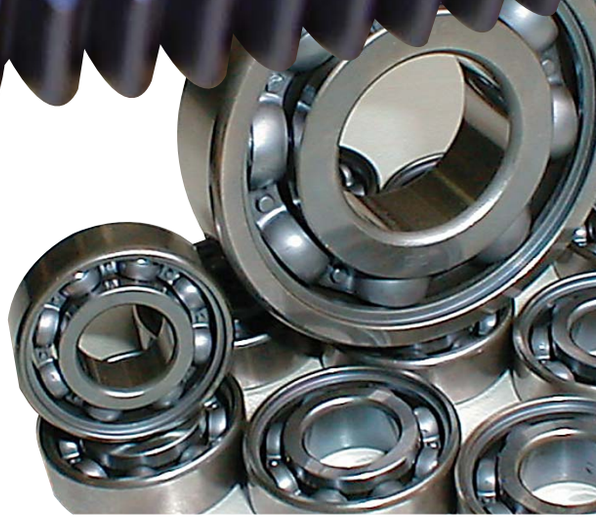
Dicronte dry lubrication met the required temperature ranges, with a design temperature range of - 188°C to +538°C, and was selected for lubrication of all sliding and rotating surfaces. A key additional consideration was that Dicronite dry lubrication, at maximum 0.5 micron thickness, would not affect the mechanical tolerances.

Dicronite dry lubrication also played a role in mass reduction. The radiused ball ends of the pins, while saving significant weight over spherical bearings, resulted in very high contact stresses.

The lubricating properties of Dicronite Dry Lubrication (coefficient of friction μ=0.030 against itself) were used to relieve this stress and provide lubrication over the life of the part.

According to NASA, since landing on Mars, Spirit and Opportunity have not only succeeded in their prime objective of finding evidence of past water and an environment that could have been suitable for sustaining at least microbial life but have chalked up one "first" after another in the annals of planetary exploration, rewriting all the books on Mars, blazing new extraterrestrial trails, and setting the standard for all other rovers to follow.

Dicronite is available throughout the world in Europe, in Germany, Italy and France.



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