

Proven Precision Dry Lubrication®

D₅ DICRONITE



www.dicronite.com

OVERVIEW

Developed as part of NASA's space exploration program, Dicronite® dry lubrication is the trusted dry lubrication technology for the aerospace, plastic molding, medical device, mechanical equipment, semiconductor and food processing industries.

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

- **Ultra-low coefficient of friction, $\mu=0.030$**
- **Precision film thickness of 0.5 micron maximum (0.000020 inches)**
- **Wide functional temperature span: -188°C to +538°C (up to +1316°C in vacuum)**
- **Near ambient temperature (max 35°C) application process**

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

- **Friction and wear reduction**
- **Anti-seize/anti-galling**
- **Plastic mold release**
- **Colubrication enhancement in combination with oils and greases**
- **In place of conventional lubricants in high-vacuum/temperature situations**

APPLICATIONS

AUTOMOTIVE



Dicronite dry lubrication is valued by the automotive industry for its ultra-low friction ($\mu=0.030$), precision tolerances (maximum 0.5 micron thickness) and wide temperature range (-188°C to +538°C). As a result, Dicronite is used to reduce friction and heat and increase performance in a broad range of automotive applications. Companies including Ford, Delphi and Eaton, as well as Eco-Team FH-Trier and several F-1 teams use Dicronite dry lubrication for:

- **Gears**
- **Valves**
- **Camshafts and Crankshafts**
- **Bearings**
- **Drivetrain components**

AVIATION



Dicronite dry lubrication is valued by the aviation industry for its ultra-low friction ($\mu=0.030$), precision tolerances (maximum 0.5 micron thickness) and wide temperature range (-188°C to +538°C), as well as its low temperature application process which does not affect the more exotic metals used in cutting-edge aviation and defense applications. Companies including Boeing, EADS, General Dynamics and Parker Hannifin use Dicronite dry lubrication for:

- **Hydraulic valve and connector lubrication**
- **Anti-galling/anti-seize protection for connectors, fasteners and rivets**
- **Flanges and couplings in fueling systems**

FOOD PROCESSING



Dicronite dry lubrication's biocompatibility per ISO-10993 and FDA repeat use and USDA incidental contact approvals have led to its use in the food processing industry. Companies including American Can and General Mills rely on Dicronite dry lubrication for:

- **Seaming and forming equipment to minimize wear and increase preventative maintenance intervals**
- **Food packaging equipment to minimize equipment jams and increase production rates**

MECHANICAL EQUIPMENT



Dicronite dry lubrication is used by the mechanical equipment industry for applications where reducing friction and heat and improving performance are critical. Companies including Timken, New Hampshire Ball Bearing, Halliburton and Tyco use Dicronite dry lubrication for:

- **Rotating and linear bearings (steel and ceramic)**
- **Gears and rotating pump components**
- **Fasteners for anti-seize and torque reduction**

MEDICAL/PHARMACEUTICAL



With its compliance to ISO 10993 biocompatibility and USP Class 6 standards, and resistance to aggressive sterilization procedures, Diconite dry lubrication provides reliable, proven performance for the medical and pharmaceutical industry. Companies including W.L. Gore, Medtronic, BD and Unilever use Diconite dry lubrication for:

- Producing sophisticated precision molded drug delivery devices
 - Increasing production line throughput by reducing container sticking in sorting and filling equipment
 - Decreasing friction in endosurgery tools and insertion devices
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PLASTICS



Diconite dry lubrication's proven ability to increase flow and speed-up release, resulting from its high lubricity ($\mu=0.030$) and precision tolerance (0.5 micron maximum), coupled with low application temperature and non flaking properties, make it the plastics industry's key dry lubrication technology. Companies including GE Plastics, Tyco, Bemis, Hayward Industrial Plastics and Univac use Diconite dry lubrication for:

- Reducing reject rates for low draft or undercut parts such as caps and closures
 - Reducing cycle times due to improved release
 - Increasing uptime due to less wear on pins, bushings and mold surfaces
 - As a co-deposit to improve the performance of TiN, CrN, CrC, and other surface treatments
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SEMICONDUCTOR



With its precise lubrication tolerances, superior performance under vacuum conditions and strong adhesion (non-contaminating), Diconite dry lubrication is valued for its ability to meet the stringent performance requirements of the semiconductor equipment industry. Companies including Applied Materials, Novellus, Parker Hannifin and RJM Semiconductor use Diconite dry lubrication for:

- Linear bearings
 - Micro-gears
 - Vacuum pump equipment
 - Fasteners
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SPACE



Diconite dry lubrication's low outgassing, precision tolerance and functionality under wide temperature and vacuum ranges have led to its widespread use in space applications. The Mars Rover Explorer and the US Space Shuttle rely on Diconite dry lubrication for sliding and rotating components. In ground-based space exploration, the Max Planck Institute's infra-red detectors rely on Diconite dry lubrication for the linear and rotational actuators operating at cryogenic temperatures.

- Instrument deployment device lubrication on the Mars Explorer Rover
 - Precision roller bearings in satellites
 - Linear and rotational cryogenic actuators in infrared detectors
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VACUUM ENVIRONMENTS



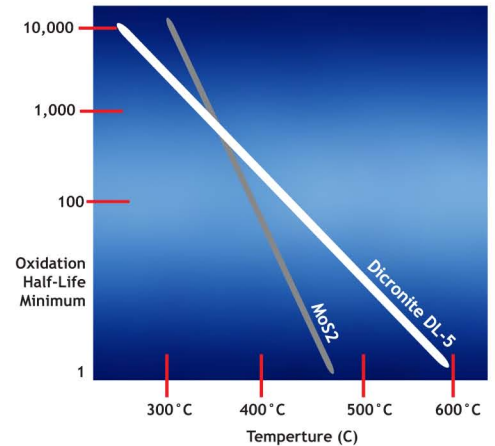
Widely used for its high performance under vacuum conditions (μ stable under vacuum), wide temperature range (cryogenic to $+1316^{\circ}\text{C}$ at 10^{-14} torr) and precision thickness (0.5 micron maximum), Diconite is the vacuum equipment industry's top dry lubrication technology. Companies including NASA, General Dynamics and Lockheed rely on Diconite dry lubrication for:

- Vacuum pump bearing lubrication
- Linear and rotational motion devices in satellites and space vehicles
- Lubrication and fretting reduction - titanium and stainless electron microscope components
- Actuators and valves

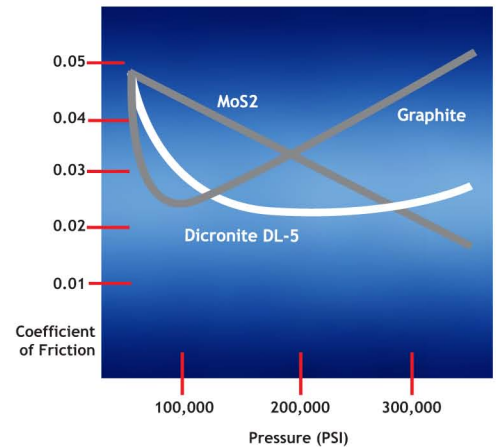
FUNCTIONAL PROPERTIES

- Coefficient of Friction - $\mu=0.030$ inclined plane method, against itself
- Temperature Range: Lubricates from -188°C to $+538^{\circ}\text{C}$ (-350°F to $+1000^{\circ}\text{F}$) normal atmosphere
- Lubricates up to $+1316^{\circ}\text{C}$ ($+2400^{\circ}\text{F}$) under 10^{-14} torr vacuum
- Chemical Stability - inert and non-toxic, compatible with all metals
- Corrosion Resistance - minor delay of corrosion, not corrosion inhibitor, does not induce corrosion
- As a Substrate - accepts most paints and is compatible with most solvents, fuels and oils
- Load Capacity - same as the substrate, to approx. 350,000 psi (approx. 2,450 MPa)
- LOX Compatibility - insensitive to detonation by or in the presence of liquid and gaseous oxygen
- Distortion/Stress - will not distort existing surfaces or create additional stresses
- Biocompatible - USP (United States Pharmacopoeia) Class 6 and ISO-10993 tested, US-FDA approved
- Very Low Outgassing (ASTM E-595)
Average TML=0.10-0.13%, Average CVCM=0.00-0.02%

Comparative Oxidation Rates



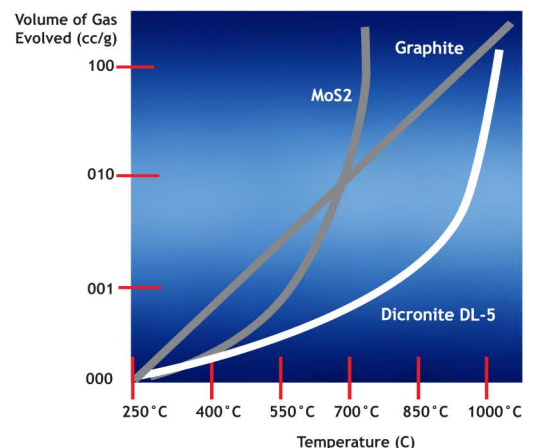
Friction as a Function of Pressure



PHYSICAL PROPERTIES

- Hardness - 1.0 - 1.5 Moh's scale.
- Thickness - 0.000020 inch (0.5 micron) maximum
- Appearance - silver-gray, polished rhodium
- No binders, adhesives or solvents
- Cure Time - no cure time required
- Magnetism - non-magnetic
- Conductive - does not affect surface electrical properties
- Substrates - bonds to metals, platings and most manmade materials
- Application temperature 20-35°C

Outgassing Characteristics in 10^{-14} torr Vacuum



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