Molybdenum Disulfide

(Bissulfeto de molibidênio)

UnivarSolutions

AGENDA

- Univar Solutions
- Solution Center
- What is Grease?
- What is Grease – Components
- Main Types of Solid Lubrication
- Features of MoS_2
- Fluid Lubricants

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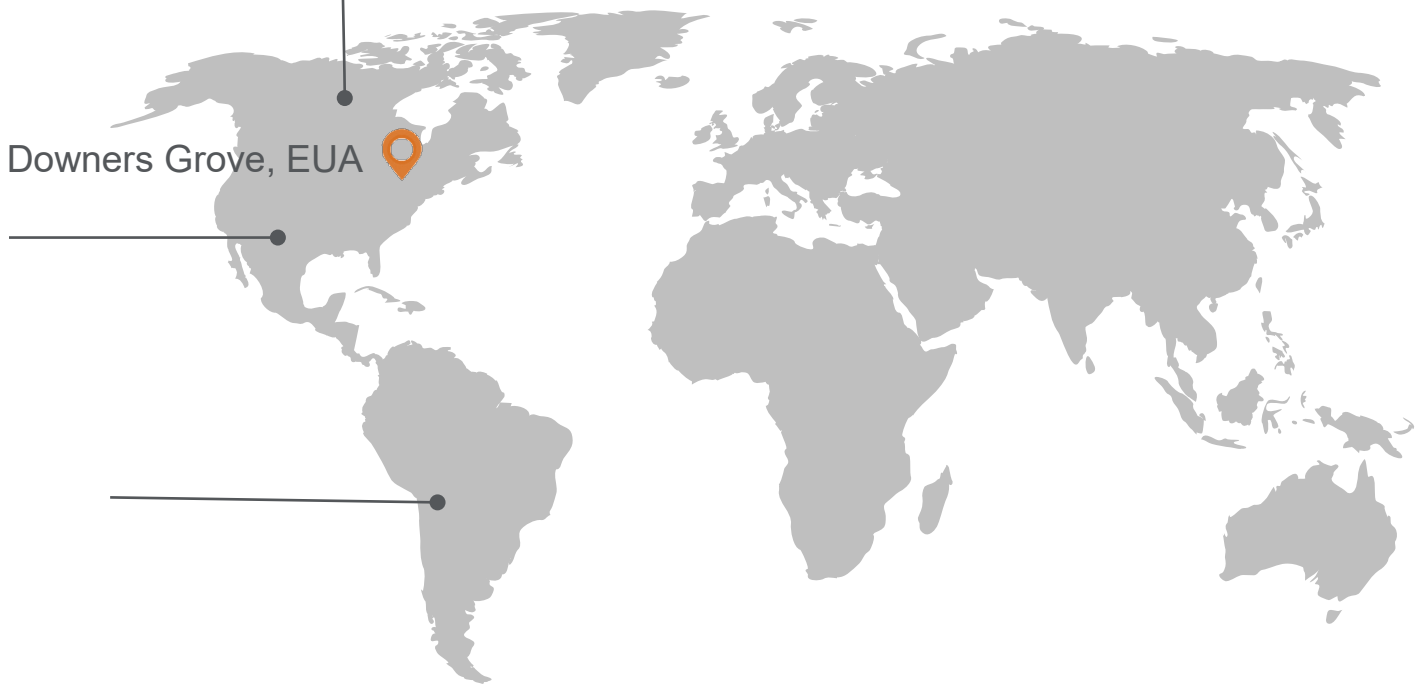
Uma força global e crescente em produtos químicos e ingredientes

CANADÁ
13%
das vendas

ESTADOS UNIDOS
64%
das vendas

LATAM & ÁSIA-PACÍFICO
4%
das vendas



EUROPA, ORIENTE MÉDIO, ÁFRICA
19%
das vendas

Uma das maiores redes de distribuição de produtos químicos e ingredientes do mundo.

Posição de mercado	Posição de Mercado	Posição de Mercado	Mais de	Em	Mais de	Entregamos para mais de	Mais de
#1	**#1**	**#2**	**10.600**	**31**	**700**	**130**	**3.500**
nos EUA	no Canadá	na EMEA	funcionários	países	instalações de distribuição	países	tratores, caminhões-tanque, reboques

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Solution Center Brazil

Solutions Center

- Promover conhecimento técnico para nossos clientes, através de aplicações de nossas matérias primas em suas formulações;
- Oferecer nossa expertise em análises como em Challenge Testes ;
- Além do suporte técnico ao nosso time comercial.

Testes

Análise internas
- Corrosão Bosch;
- Teste de espuma;
- Karl Fisher;
- Viscosidade Cinemática & Dinâmica;

Análise externas
- Four Ball;
- Ponto de gota;
- Contagem de partículas;
- Índice de Acidez;
- Entre outros.

What is Grease?

- The National Lubricating Grease Institute defines grease as, “a solid to semi-solid product of dispersion of a thickening agent in a liquid lubricant. Additives imparting special properties may be included (1).”

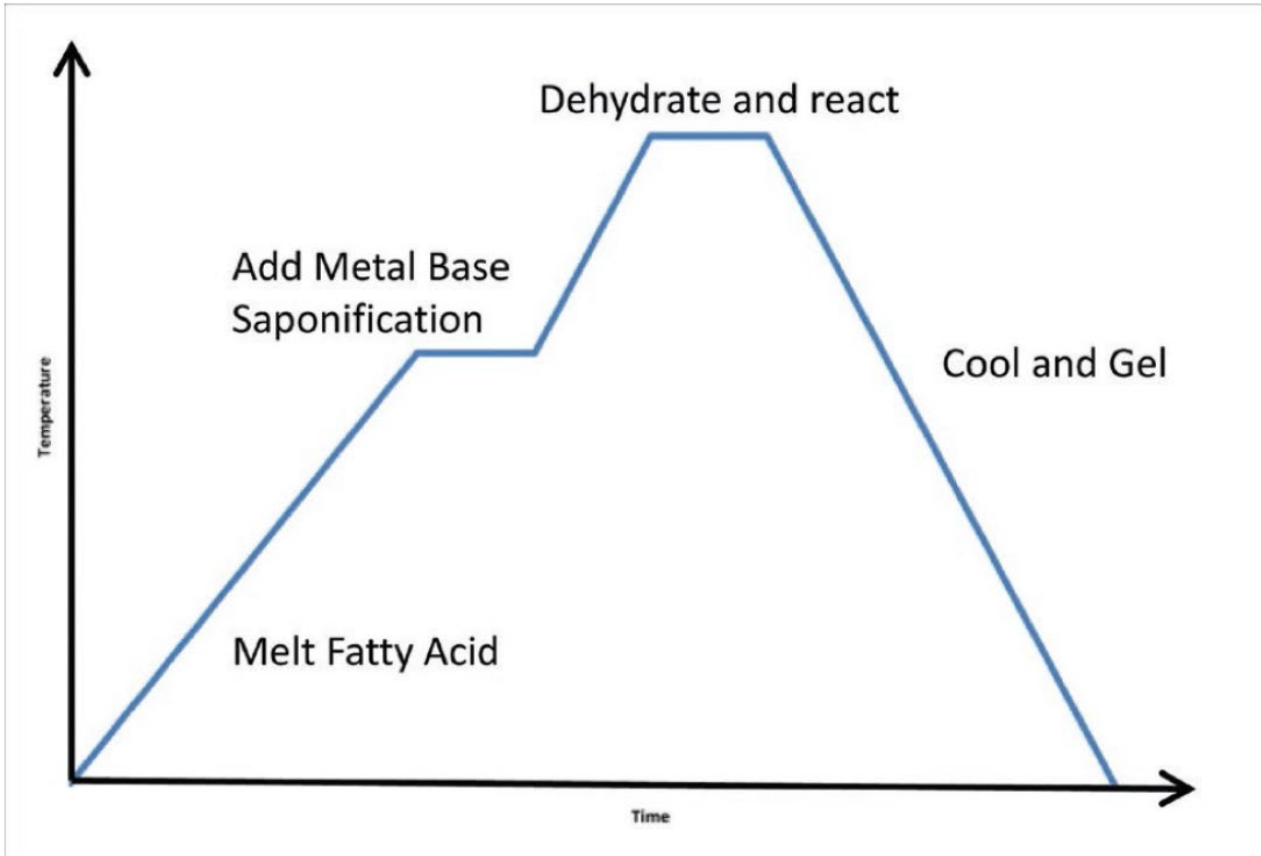


Figure 1. Greasing-making process: basically acid + base = soap + water.

Total global market size of lubricating grease is about 2.38 billion pounds

What is Grease - Components

- The components of grease
  - Base Oil (50% - 98%)
  - Thickeners (2% - 50%)
  - Additives (0% - 10%)

NLGI consistency numbers

NLGI number	ASTM worked (60 strokes) penetration at 25 °C *tenths of a millimetre*	Appearance	Consistency food analog
000	445-475	fluid	cooking oil
00	400-430	semi-fluid	apple sauce
0	355-385	very soft	brown mustard
1	310-340	soft	tomato paste
2	265-295	"normal" grease	peanut butter
3	220-250	firm	vegetable shortening
4	175-205	very firm	frozen yogurt
5	130-160	hard	smooth pâté
6	85-115	very hard	cheddar cheese

What is Grease – Base Oils

- **Base Oil (50% - 98%)**
  - Mineral
    - Group I
    - Group II
  - Synthetic
    - Group III:
    - PAO
    - PAG
    - Esters

What is Grease - Thickeners

- Thickeners (2% -50%)
  - **Soap**
    - Lithium/Lithium Complex
    - Calcium/Calcium Complex
    - Aluminum/Aluminum Complex
    - Sodium
  - **Non-Soap**
    - Polyurea
    - Organophilic Clay
    - Fumed Silica
    - Silicone

	Aluminum Complex	Lithium	Calcium	Bentone	Lithium Complex
Water Resistance	Excellent	Good-Excellent	Good	Excellent	Excellent
Mechanical Stability	Good-Excellent	Excellent	Poor	Good	Good
Compatibility	Fair	Good-Fair	Good-Fair	Good-Fair	Good-Fair
Dropping Point	475°F(246°C)	360°F(182°C)	350°F(1 77°C)	500°F(260°C)	500°F(260°C)
Heat Reversion	Excellent	Good	Poor	Good	Good
Low Temperature Pumpability	Excellent-Good	Good	Poor	Poor	Poor

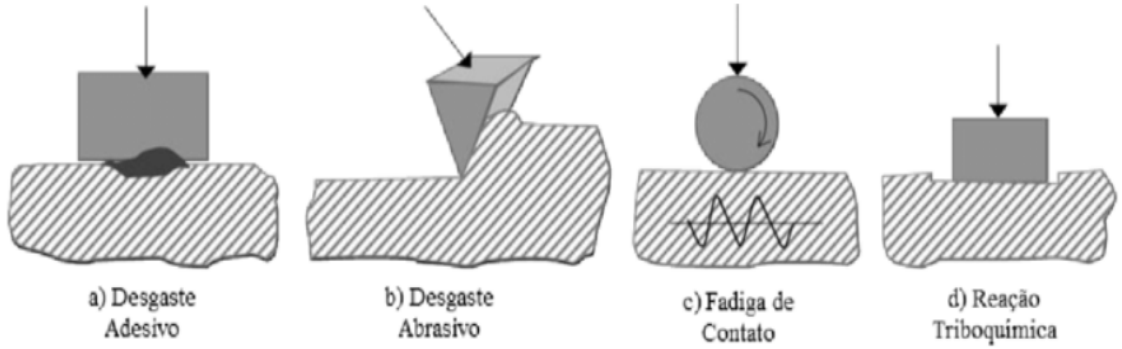
Comparisons for typical NLGI 2 grade greases before addition of any special EP or wear-reducing additives, solids or trace colors.

What is Grease - Additives

- Additives (0 – 10%)
  - Antioxidant
  - Antiwear
  - Extreme Pressure
  - Corrosion Inhibitor
  - Pour Point Depressant
  - Friction Modifier
  - Dye
  - Tackifier
  - Viscosity Modifier

Main Types of Wear

- Adhesive wear: Caused by adhesion of micro-asperities of friction surfaces
- Abrasive wear: Caused by cutting by hard, foreign particles or abrasive particles in oil
- Surface fatigue wear: Caused by surface fatigue resulting from repeated stress
- Chemical wear: Dominated by chemical reactions between friction surfaces and lubricant molecules



Main Types of Solid Lubrication

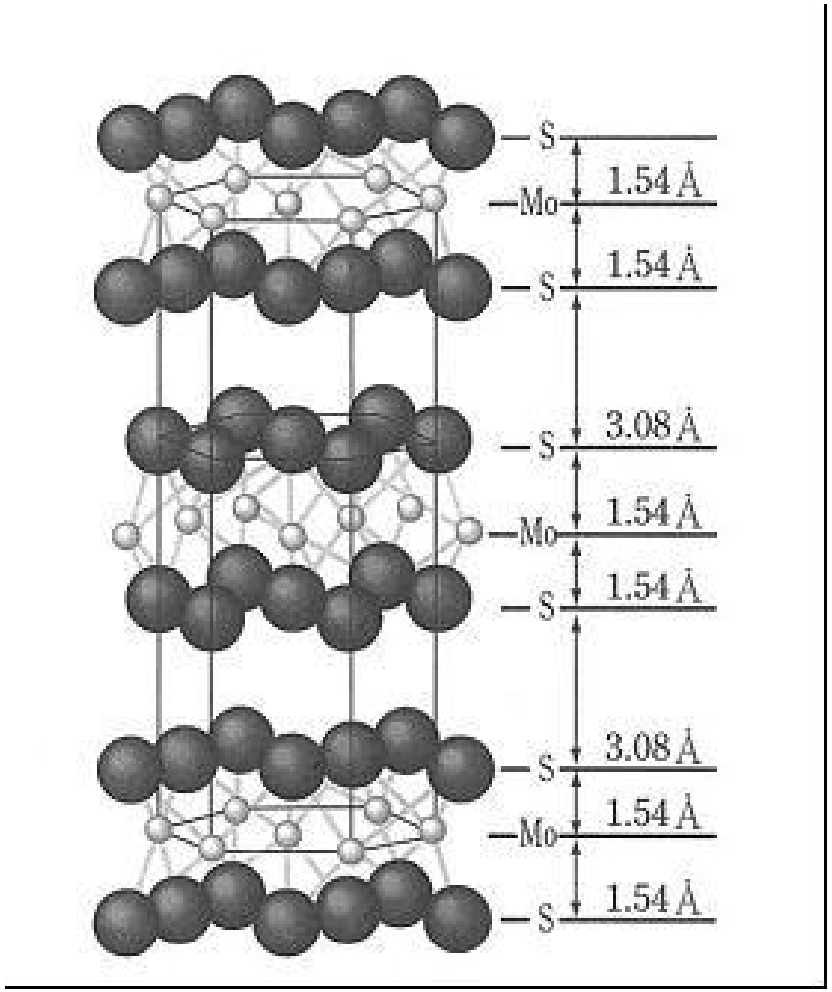
- Fats, soap, wax
- Soft metallic film
- Polymers
- Non-lamellar film
- Lamellar film

Lubrication Additives

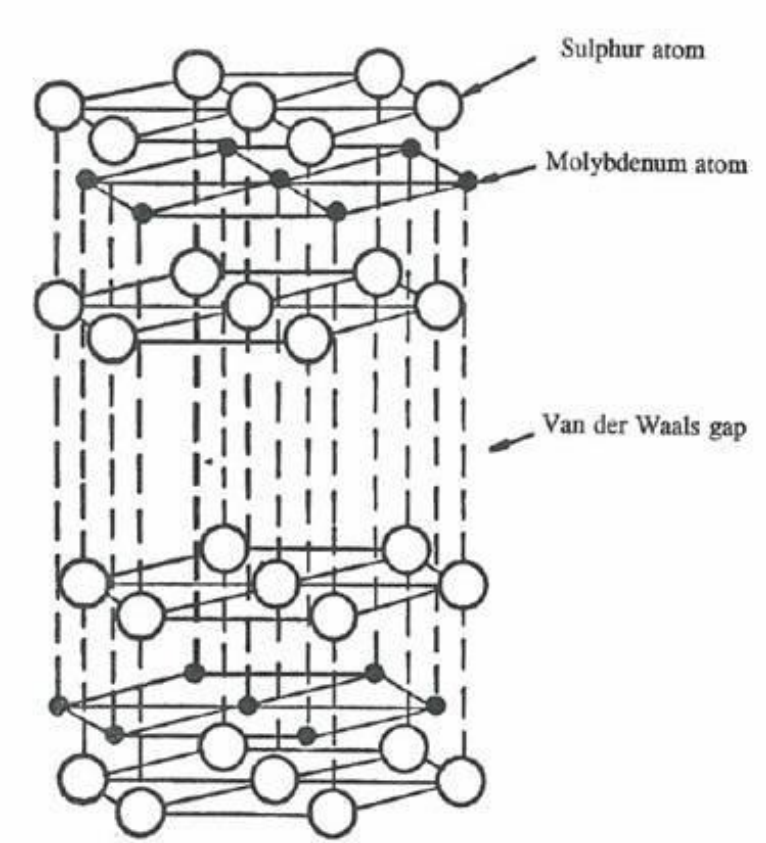
Property	MoS_2	WS2	Graphite	PTFE	Talc/Clay
Particle Size	2-20 microns	2-20 microns	2-20 microns	1-20 microns	1-20 microns
High Loads / EP (dry)	Excellent	Excellent	Fair	Exc. (low speed)	Good
High Loads / EP (wet)	Excellent	Excellent	Excellent	Exc. (low speed)	Good
Shock Loading / Low Temp.	Excellent	Excellent	Good	Good	Good
High Temp. Limits	400 C	650 C	450 C	260 C	900 C
Friction Reduction	Good	Good	Good	Excellent	Good
Purity	~ 98%	100%	~ 98%	100%	~ 98%
Dirty Environments	Excellent	Excellent	Excellent	Excellent	Good
Equivalent Cost per lb	$ 10 - $20	$ 75 - $150	$ <1 - 3	$ 8 - 12	$ <1 - 3

Features of MoS_2

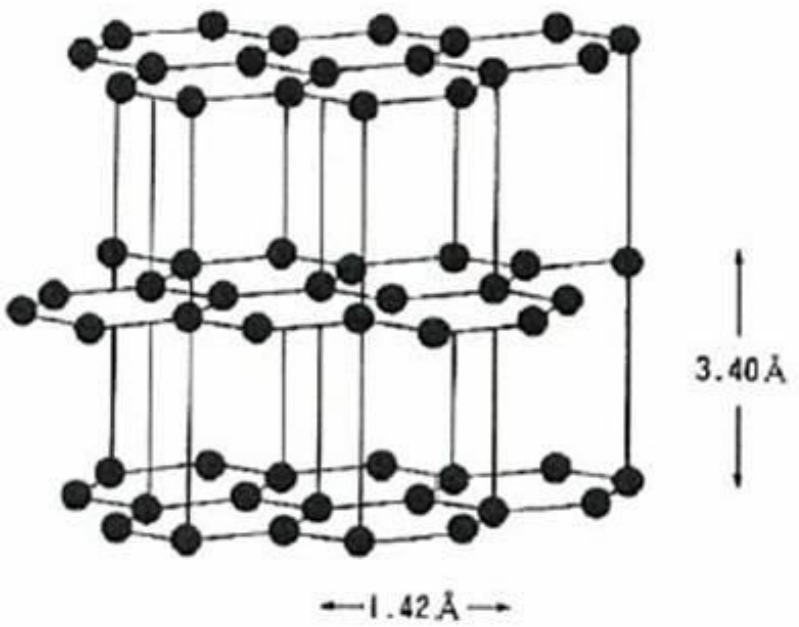
- Layer Lattice Crystal Structure
- Crystalline forms – hexagonal and rhombohedral
- Strong Covalent Bonds within S-Mo-S
- Layers and Weak Bonds between Layers
- Easy Cleavage (Shearing) of S-S Bonds
- Optimal Distribution of Electrons on S-Mo-S Layer
- Affinity for Metal Substrate Reduces Asperity Interaction
- Intercalation



MoS_2 and Graphite Crystal Structure



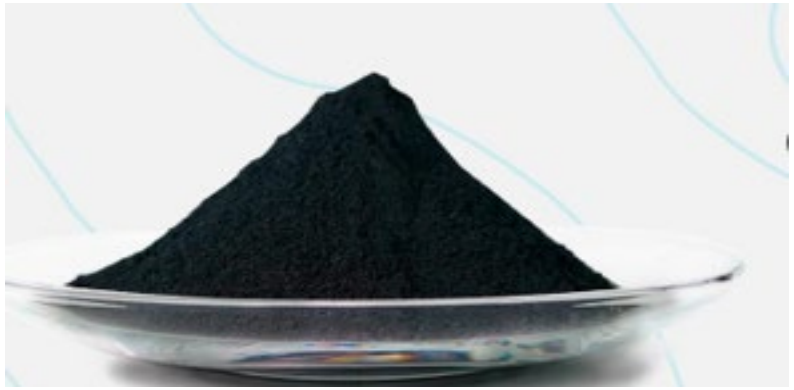
MoS_2



Graphite

Physical Properties of MoS_2

Density	5060 kg/m3
Color	blue gray to black
Molecular Weight	160.08
Crystal Form	Hexagonal, rhombohedral
Electrical Conductivity	Low but variable
Vacuum Lubrication	Excellent
Radiation Stability	Good
Hardness	Highly anisotropic
Magnetic Properties	Diamagnetic
Dissociation Temp.	1370 0C (non-oxidizing environment)
Sublimation Temp.	1050 0C in high vacuum



Chemical Properties of MoS_2

- Generally MoS_2 chemically very inert
  - resistant to attack by most acid
  - exceptions: hot concentrated sulfuric, nitric acid and hydrochloric acid
  - slow reaction with HF
  - reaction with chlorine produce Mo pentachloride
- Oxidizes to MoO3in air (370 0C)
- Thermally stable in vacuum and inert atmospheres to 1000+ 0C
- Insoluble in oil and water

Greases

- **Effect of MoS_2** in greases
  - Helps preserve machine components
  - Does not attract dirt or abrasive particles;
  - It is not affected by other chemicals;
  - It is resistant to high temperatures;
  - Protects against corrosion and moisture;
- **Implementation of solids** in greases
  - equipment in which contact, and sliding are continuous.
  - pins,
  - ball joints,
  - Bushings,

Fluid Lubricants

- **Effect of MoS_2** in lubricating oils
  - reduce friction and wear
  - increased load-carrying capacity
  - may prevent/delay catastrophic seizure

Implementation of solids in lubricating oils

  - in gears (specially worm, helical and hypoid gears)
  - in metal-forming / metal-cutting
  - Mainly SF grade for lubricant oils

- **Commercial Dispersions** in oils
  - Concentrated dispersions for blending into mineral oil
  - Less concentrated dispersion

Para mais informações entre em contato com a equipe técnica da Univar.

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QUESTIONS?

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