

Borophene-Based Green Lubricant

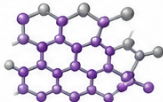
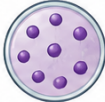
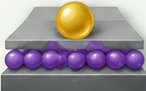
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Why in News?

Recently, scientists from IASST, Guwahati, have demonstrated for the use of borophene, as a high-performance lubricant additive in castor oil.

- **Definition** - Borophene is a two-dimensional (2D) nanomaterial composed of a single atomic layer of boron atoms.
- **Properties**
 - High mechanical strength
 - Excellent thermal conductivity
 - High electrical conductivity
 - Superior chemical stability
 - Excellent load-bearing capability
- **Innovation** - A minimal concentration of 0.1 wt.% borophene was incorporated into castor oil by the researchers.
- The incorporation of the nano-additive resulted in a substantial improvement in lubrication performance, without necessitating chemical modification of the oil.

KEY FINDINGS: BOROPHENE-BASED GREEN LUBRICANT

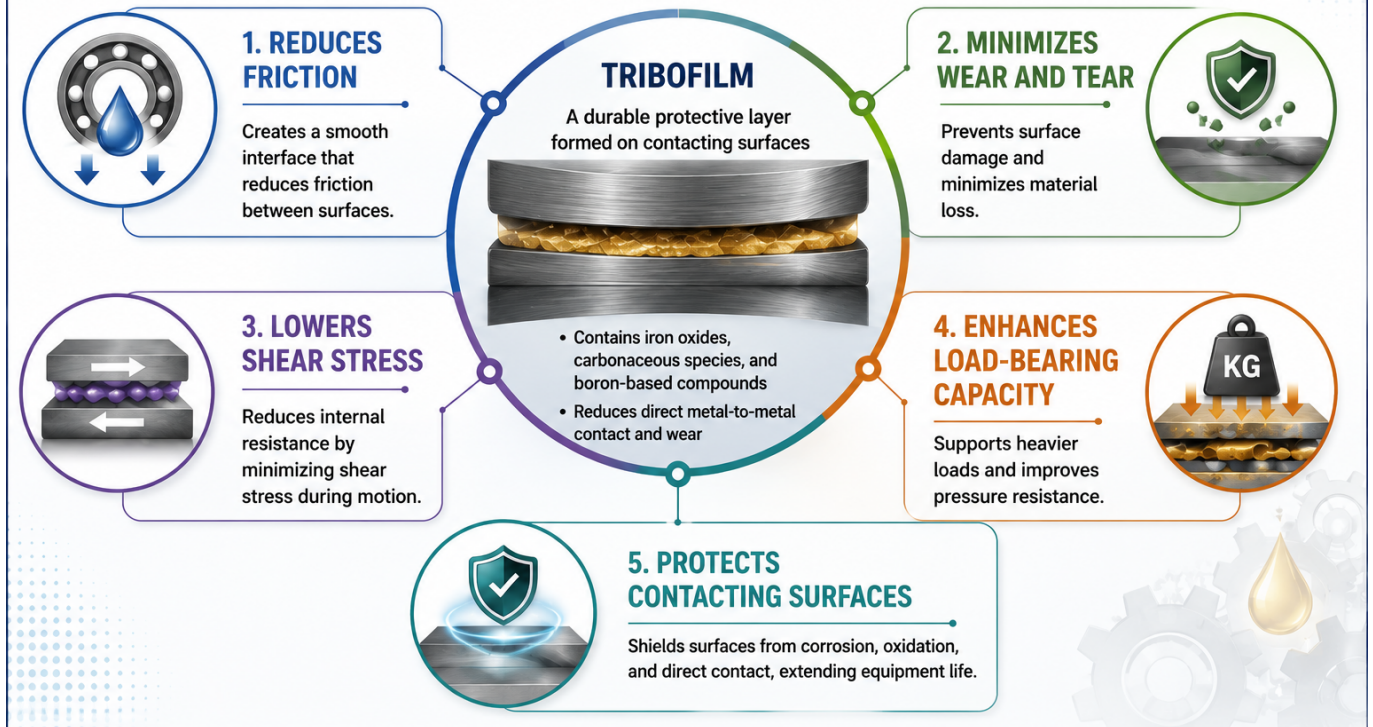
PARAMETER	OBSERVATION
 LUBRICANT USED	 Castor Oil + 0.1 wt.% Borophene
 REDUCTION IN FRICTION	 ≈42% compared to pure castor oil
 DISPERSION	 Uniformly dispersed without chemical modification
 PROTECTIVE LAYER	 Durable tribofilm formed during operation
 OVERALL IMPACT	 Improved lubrication  Reduced wear  Enhanced machine efficiency

- **Mechanisms** - During operation, borophene generates a *protective tribofilm* composed of the following components:

- Iron oxides
- Carbonaceous compounds
- Boron-based compounds

FUNCTIONS OF THE TRIBOFILM

The tribofilm formed during operation plays a crucial role in enhancing lubrication performance and protecting machinery.



• Key Advantages

- **Energy Efficiency** - Borophene-based bio-lubricants reduce energy losses associated with friction.
- These lubricants contribute to improved operational efficiency in machinery.
- **Sustainability** - They utilize renewable and biodegradable castor oil as a base component.
- Their use reduces reliance on petroleum-based lubricants.
- **Equipment Protection** - Borophene-based bio-lubricants minimize wear and surface degradation of mechanical components.
- This protection extends the operational lifespan of machinery.
- **Environmental Benefits** - Borophene-based bio-lubricants are environmentally friendly alternatives to conventional lubricants.

- Their adoption supports sustainable manufacturing practices.

- **Applications**

- Renewable energy systems, including wind and solar power equipment
- Marine industry applications
- Heavy industrial machinery and equipment
- Automotive lubrication systems
- Green manufacturing processes
- Sustainable lubrication technologies

Institute of Advanced Study in Science and Technology (IASST)

- An autonomous institute under the Department of Science and Technology (DST).

- **Located in** - Guwahati, Assam.

- **Objectives**

- To provide advanced analytical facilities for interdisciplinary sciences.
- To assist researchers from IASST, other institutes, and industries.
- To upgrade and maintain state-of-the-art infrastructure for research excellence.

Reference

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