Advancing Carbon Nanomaterials for Reduction of Automotive Engine Friction by using h-BN nanosheets and spherical W nanoparticles additives: A Hypothesis using Molecular Dynamics Simulation

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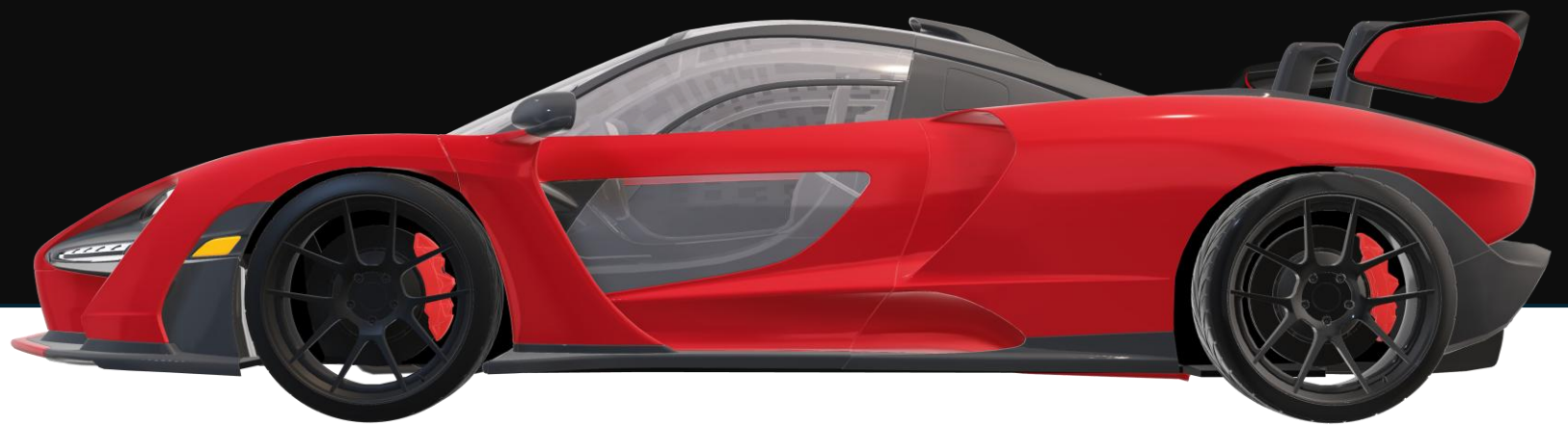
CONTENTS

- Aim of the study
- Introduction
- Nano-lubricants
- Challenges and future directions
- Proposed Hypothesis
- Conclusion



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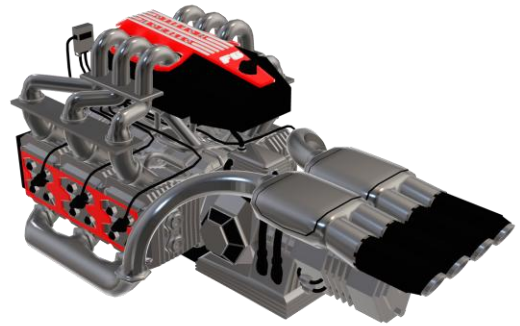
AIM OF THE STUDY

- Study of nano-lubricants for Internal Combustion Engines.
- Properties of nano-lubricants which help in the improvement of anti-friction and wear resistance.
- Overview of how nano-lubricants can improve tribological properties.
- Materials used as nano-lubricants.
- A hypothesis on additives in materials and alloys to improve the tribological properties using Molecular Dynamics.



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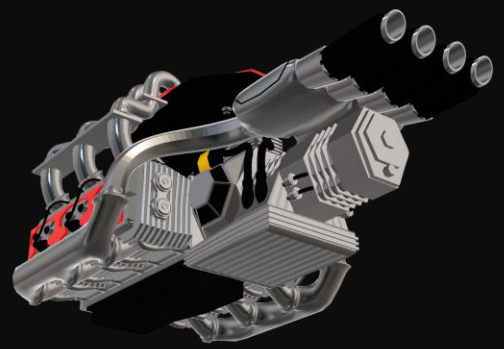
INTRODUCTION

- Internal Combustion Engine (ICE) is a key component of automobiles.
- Efforts are made to improve anti-friction/wear properties in automobile engines using nano-lubricants.
- Usage of nano-lubricants:
  - Overcoming energy loss due to friction.
  - Reducing tribological properties like friction and wear resistance.
  - Environment friendly.



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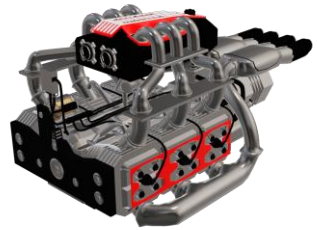
NANOLUBRICANTS



- Definition: Dispersion of nanoparticles in base oil/lubricant.

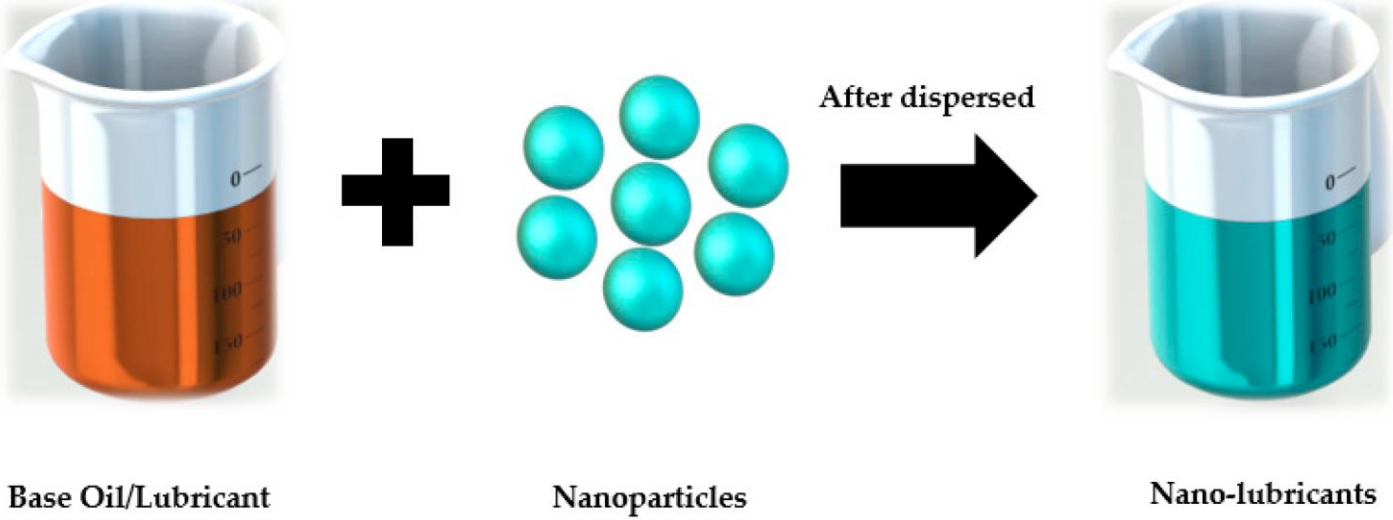


Fig 1. Synthesis of Nano-lubricants

Jason, Yeoh Jun Jie, et al. "A study on the tribological performance of nanolubricants." Processes 8.11 (2020): 1372.

SYNTHESIS OF NANOLUBRICANTS

- Two methods: One-step method & two-step method.
- One-step method:
  - Nano-lubricants are directly formulated through a chemical process.
- Two-step method:
  - First, nanomaterials are synthesised in powdered form through physical or chemical methods.
  - Second, disperse into base oil.

Jason, Yeoh Jun Jie, et al. "A study on the tribological performance of nanolubricants." Processes 8.11 (2020): 1372.

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CARBON NANOMATERIALS AS NANOLUBRICANTS

Carbon nanomaterials:

- Improve tribological behaviour and thermo-physical properties in engine oils.
- Provide greater-friction and wear resistance properties.
- Spherical shaped; minimizing sliding contact area and reduce adhesion during friction at loading conditions.

Challenges

Carbon nano-additives as nano-lubricants achieves good results yet there are a few challenges.

1. **Dispersion and Stability**: Dispersion stability refers to the even distribution of nanoparticles in the lubricant over time.
2. **Compatibility with additives** : The addition of nanoparticles to the nano-lubricant can result in increased viscosity.

Future Recommendations by Current Researchers

- Further explore the anti-friction mechanisms of carbon nanomaterials with molecular dynamics simulation.
- Additive used in carbon nanomaterials to enhance lubricity at nanoscale for friction control in automotive engines.
- Assessing the toxicity of the nano-lubricants and eliminating potential health hazards.

Kotia, Ankit, et al. "Carbon nanomaterials as friction modifiers in automotive engines: Recent progress and perspectives." *Journal of Molecular Liquids* 310 (2020): 113200.

Proposed Hypothesis

Addition of hexagonal Boron Nitride (h-BN) and spherical tungsten (W) nanoparticles in carbon nanomaterials to further explore anti-friction mechanism using molecular dynamics simulation.

Advantages:

- h-BN and W nanoparticles in base oil decrease coefficient of friction and wear rate.

- Molecular Dynamics (MD) shows BN nanosheets to base oil improves tribological performance [3].

- MD and in-situ TEM mechanical tests provide positive effect of adding h-BN and W nanoparticles [3].

Bondarev, A. V, et al. "Mechanisms of friction and wear reduction by h-BN nanosheet and spherical W nanoparticle additives to base oil: Experimental study and molecular dynamics simulation." *Tribology International* 151 (2020): 106493.

Proposed Hypothesis (cont.)

- Carbon nanomaterials are known to provide greater friction and wear resistance properties compared to base oils [2].

- Based on future recommendations provided, we propose a hypothesis to use h-BN and W nanoparticles and their combination as lubricant additive to carbon nanomaterials.

- The hypothesis is supposed to improve anti-friction and wear resistance.

Bondarev, A. V, et al. "Mechanisms of friction and wear reduction by h-BN nanosheet and spherical W nanoparticle additives to base oil: Experimental study and molecular dynamics simulation.“ *Tribology International* 151 (2020): 106493.

References

[1] Jason, Yeoh Jun Jie, et al. "A study on the tribological performance of nanolubricants." Processes 8.11 (2020): 1372.

[2] Kotia, Ankit, et al. "Carbon nanomaterials as friction modifiers in automotive engines: Recent progress and perspectives." Journal of Molecular Liquids 310 (2020): 113200.

[3] Bondarev, A. V, et al. "Mechanisms of friction and wear reduction by h-BN nanosheet and spherical W nanoparticle additives to base oil: Experimental study and molecular dynamics simulation.“ Tribology International 151 (2020): 106493.

Thank you!

Questions?