

17th International Scientific Conference on Energy and Climate Change
9-11 October 2024 (Athens, Greece)

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Enhanced Biolubricant Formulations through Nanoparticles Dispersion

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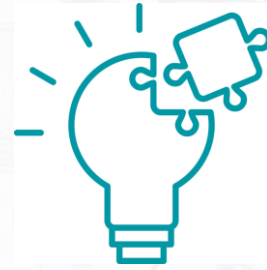


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Presentation Outline

1. Introduction
2. Materials and Methods
(M&M)
3. Results and Discussion
(R&D)
4. Conclusions



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2



3



4



Intr. – Why Lubricants Are Essential (1/2)

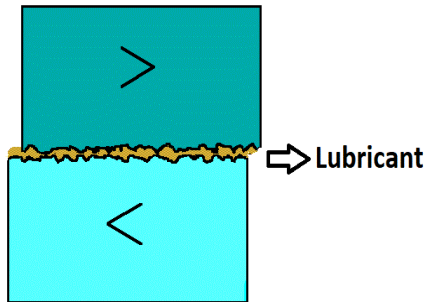
Functionality:

Reduce Friction

Heat Dissipation

Corrosion Prevention

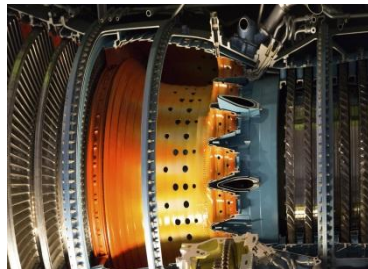
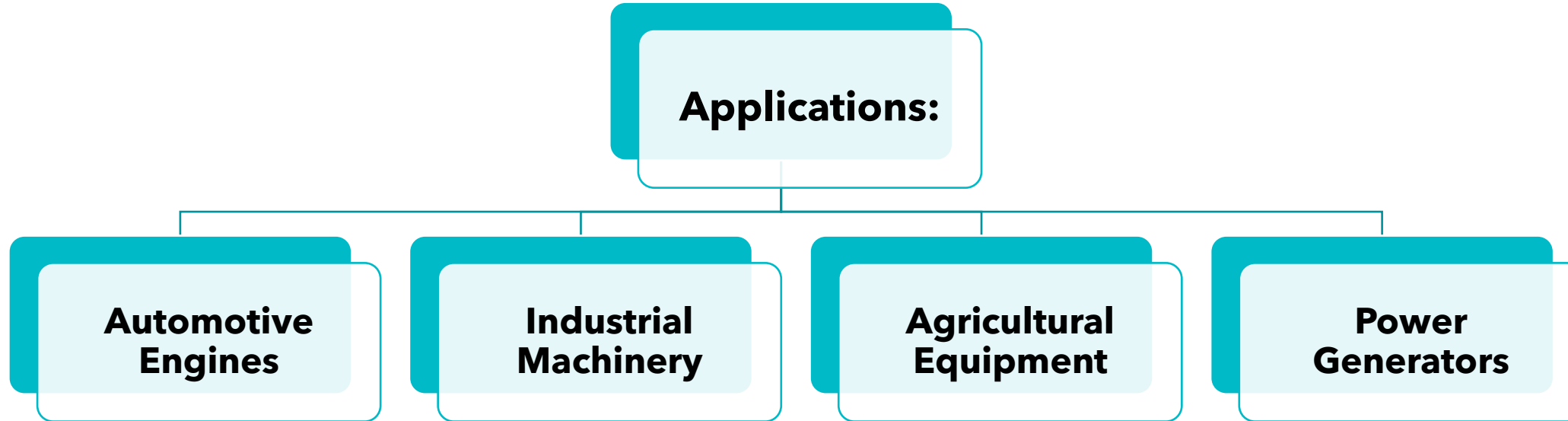
Contaminant Removal



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Intr. – Why Lubricants Are Essential (2/2)



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Intr. – Challenges and Solutions

Significant drawbacks of conventional lubricants :

- Frequent Changes
- Environmental Impact

Need for advanced solutions:

- Enhance performance and longevity
- Align with environmental sustainability goals



THE POTENTIAL OF NANOTECHNOLOGY



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1



Intr. – SiO₂ Nanoparticles, Biolubricants

Why SiO₂ Nanoparticles?

- Strong biocompatibility
- Heat resistance and stability
- Non-toxic and environmentally friendly



Why Biolubricants?

- Derived from renewable sources
- Biodegradable and less harmful in spills
- Made from vegetable/animal fats
- Reduce dependency on fossil fuels



1



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Intr. – Combined Solution

The most promising solution:

- Joint exploitation of SiO_2 nanoparticles and biolubricants



Benefits of Nanobiolubricants:

- Enhanced efficiency and sustainability
- Reduced environmental impact
- Improved machinery performance and longevity



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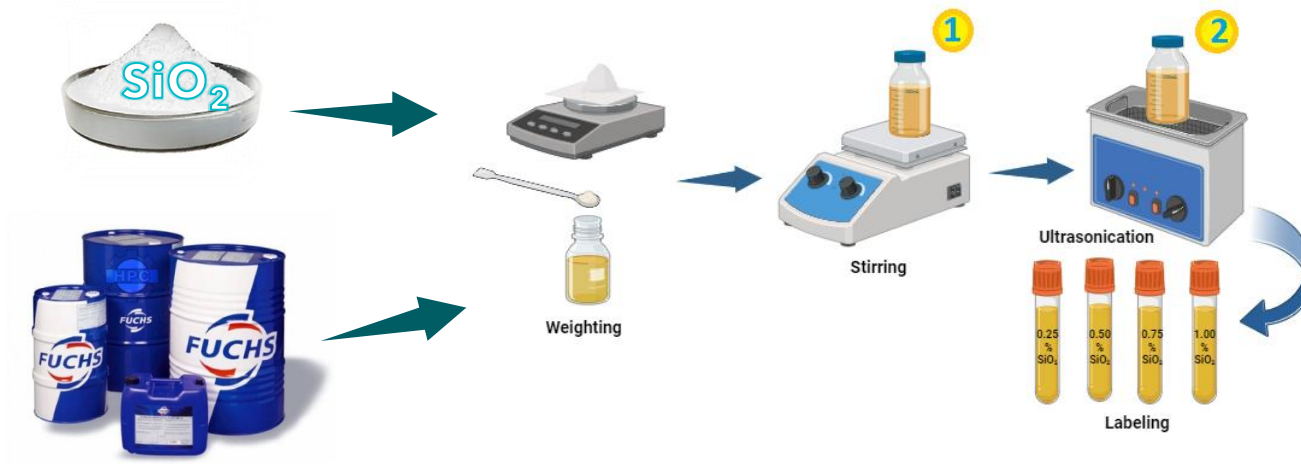


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M&M – Preparation of Nanobiolubricants

- The nanobiolubricants in this study were prepared using a two-step technique



Composition and Specifications of nanobiolubricants:

Sample Number	SiO_2 (wt%)	Stirring Time (h)	Sonication Time (h)
1.1	0.25	1.5	0.0
1.2	0.25	1.5	1.0
1.3	0.25	1.5	2.5
2.1	0.50	1.5	0.0
2.2	0.50	1.5	1.0
2.3	0.50	1.5	2.5
3.1	0.75	1.5	0.0
3.2	0.75	1.5	1.0
3.3	0.75	1.5	2.5
4.1	1.00	1.5	0.0
4.2	1.00	1.5	1.0
4.3	1.00	1.5	2.5



M&M – Performed experiments

- **The stability of the nanoparticles' dispersion**
 - ✓ Sedimentation photography
 - ✓ FTIR (Fourier Transform Infrared Spectroscopy)
 - ✓ UV-Vis spectrophotometry
- **Physicochemical Properties of Nanobiolubricants**
 - ✓ Viscosity
 - ✓ TAN (Total Acid Number) & TBN (Total Base Number)
 - ✓ FTIR(Fourier Transform Infrared Spectroscopy)
 - ✓ ICP (Inductively Coupled Plasma)



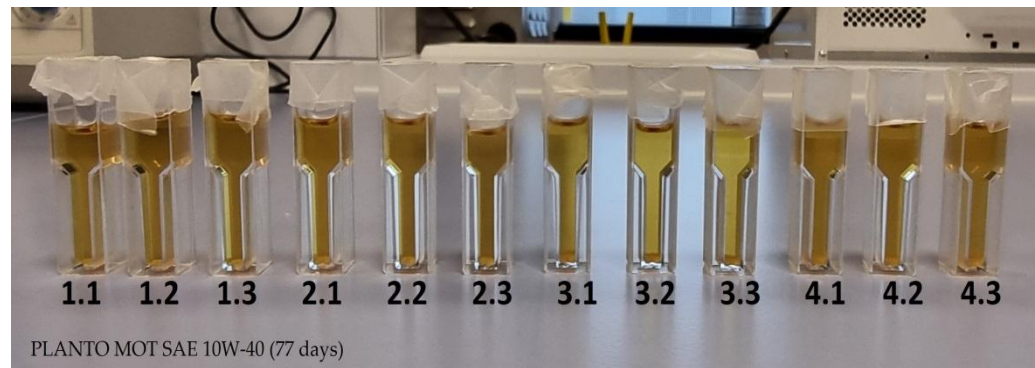
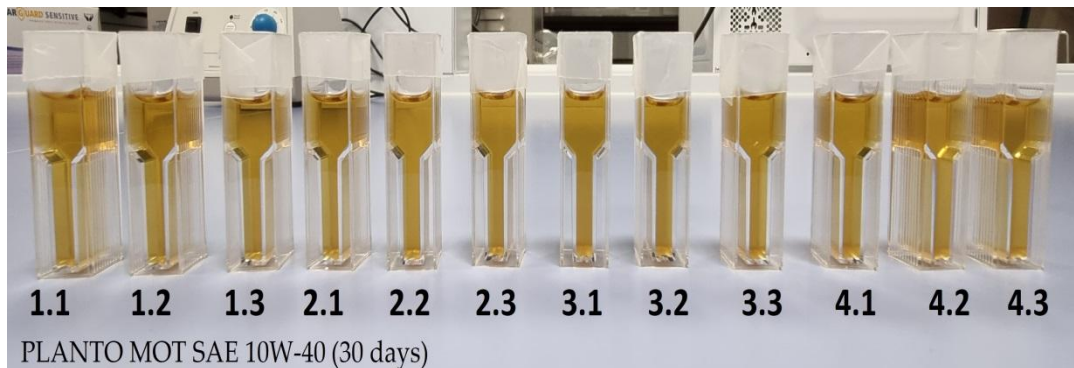
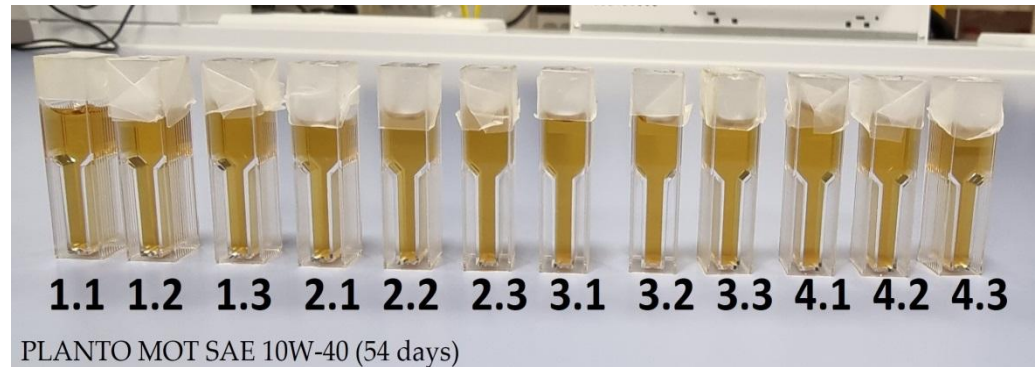
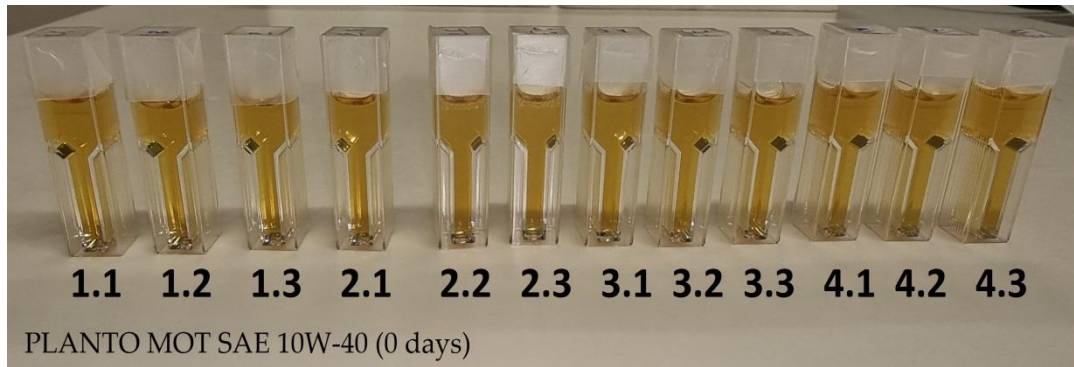
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R&D – Evaluat. of Nanop. Sedimentation (1/3)

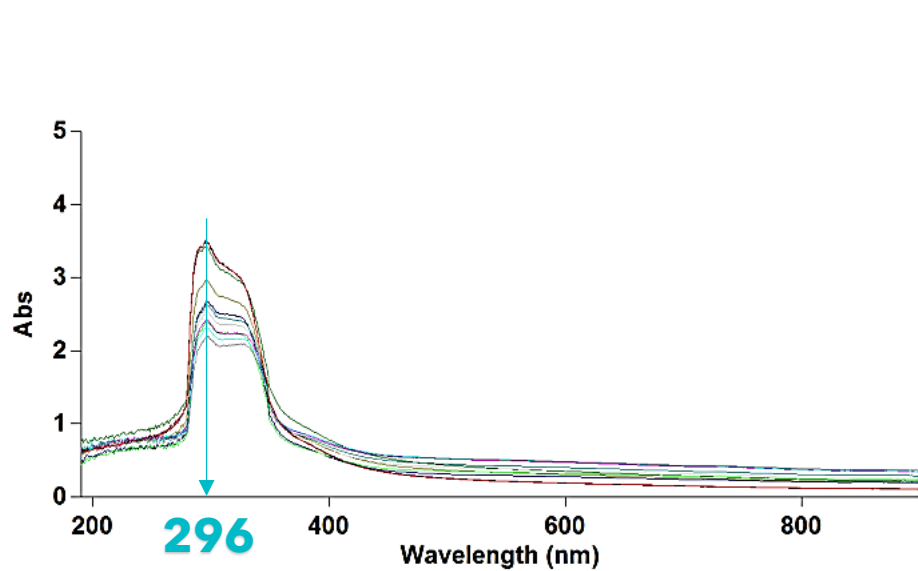
- Static stability of nanobiolubricant samples with different sonication times



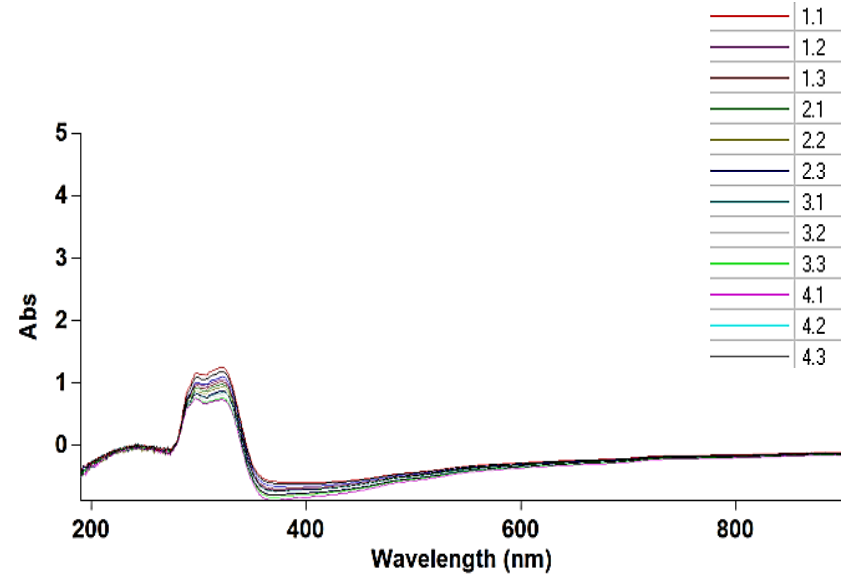
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R&D – Evaluat. of Nanop. Sedimentation (2/3)

- UV-Vis Analysis of Nanoparticle Dispersion



SiO₂/PLANTO MOT SAE 10W40 nanobiolubricants after preparation



SiO₂/PLANTO MOT SAE 10W40 nanobiolubricants after 77 days.



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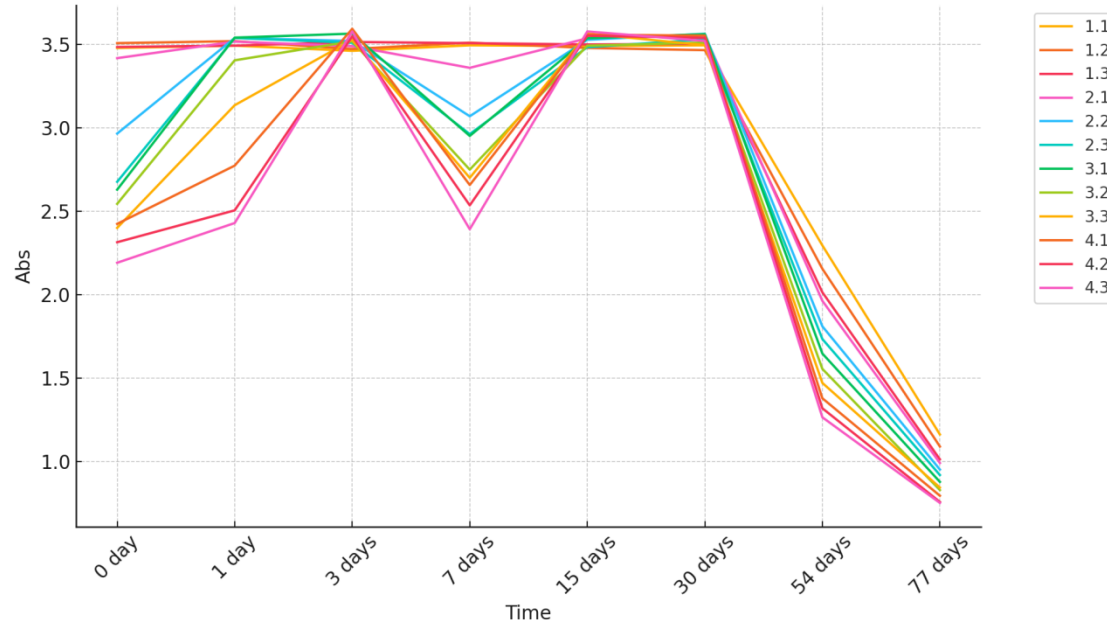


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R&D – Evaluat. of Nanop. Sedimentation (3/3)

- UV-Vis Analysis of Nanoparticle Dispersion



UV-Vis evaluation of SiO₂/PLANTO MOT SAE 10W40 nanobiolubricants for 77 days at different concentrations with different sonication times.



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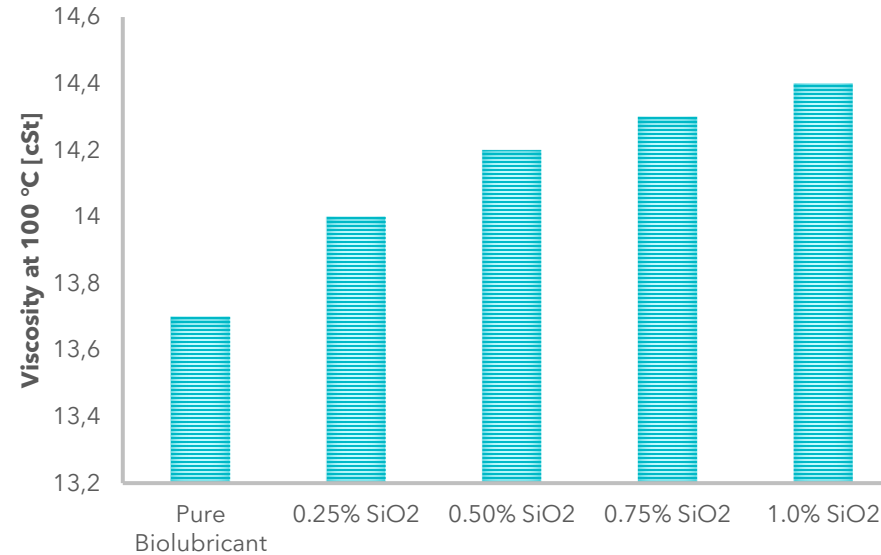
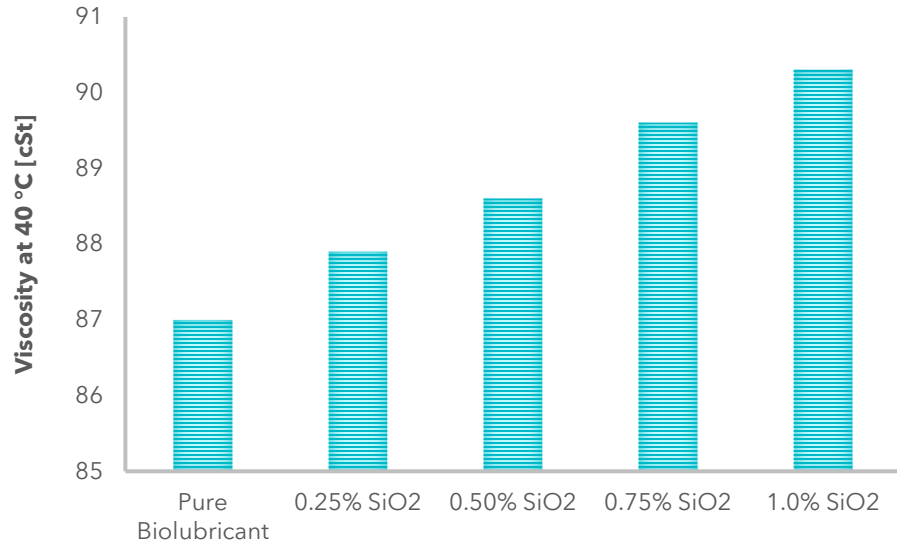
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R&D – Evaluat. of Nanop. Characterization (1/6)

- Characterization and Assessment of Nanobiolubricants

Physicochemical Properties of Nanobiolubricants.



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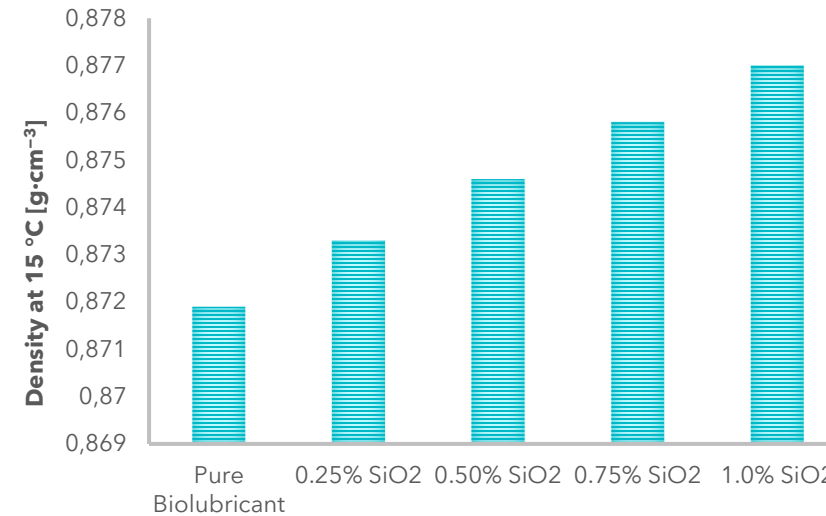
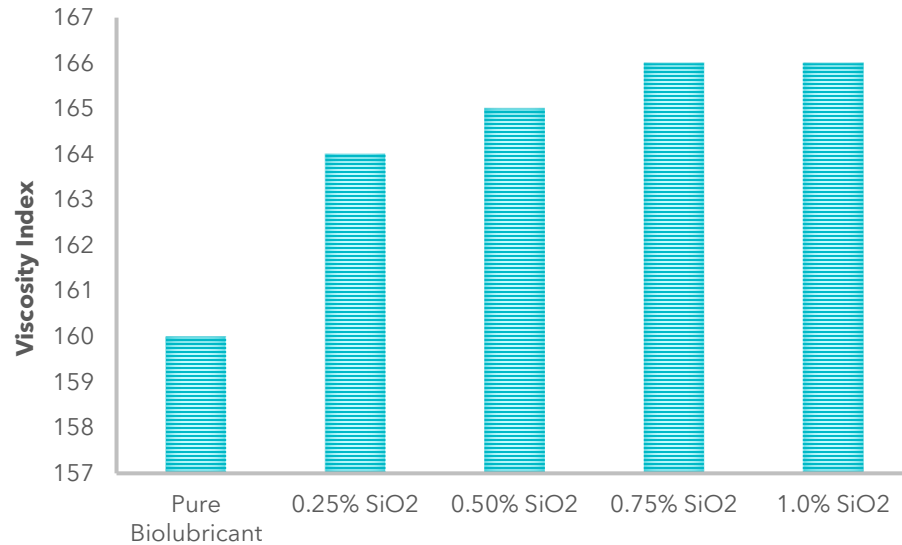


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R&D – Evaluat. of Nanop. Characterization (2/6)

- Characterization and Assessment of Nanobiolubricants

Physicochemical Properties of Nanobiolubricants.



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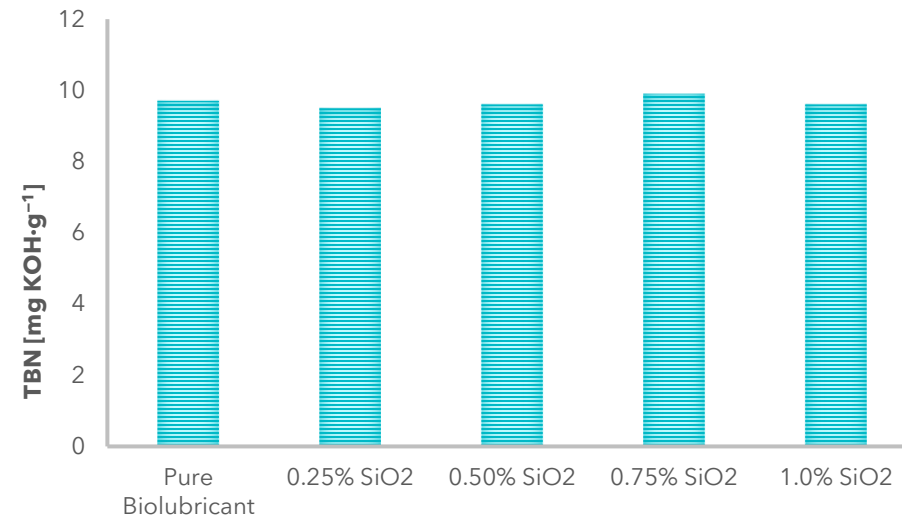
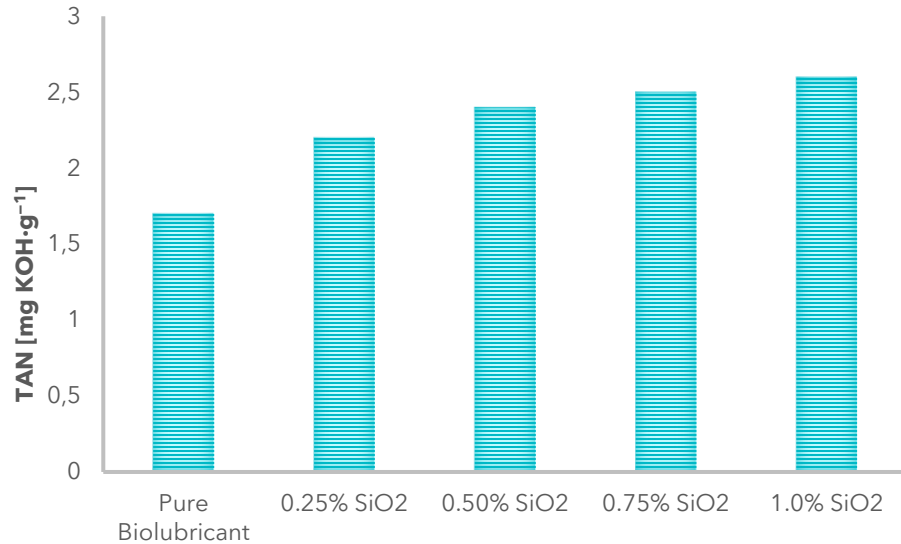


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R&D – Evaluat. of Nanop. Characterization (3/6)

- Characterization and Assessment of Nanobiolubricants

Physicochemical Properties of Nanobiolubricants.



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3



R&D – Evaluat. of Nanop. Characterization (4/6)

- Characterization and Assessment of Nanobiolubricants

ICP-OES analysis

Properties	Biolubricant (Pure) SAE 10W40	Nanobiolubricants 0.25% SiO ₂	Nanobiolubricants 0.50% SiO ₂	Nanobiolubricants 0.75% SiO ₂	Nanobiolubricants 1.00% SiO ₂
Silicon (pollution) [ppm]	2	337	702	1020	1402
Sodium (pollution) [ppm]	0	0	0	0	5
Calcium (additive) [ppm]	1672	1720	1737	1720	1761
Magnesium(additive) [ppm]	333	345	353	351	359
Zinc (additive) [ppm]	693	690	678	668	658
Phosphorus (additive) [ppm]	593	596	594	587	591
Boron (additive) [ppm]	487	472	459	462	476
Molybdenum (additive) [ppm]	74	73	75	73	74

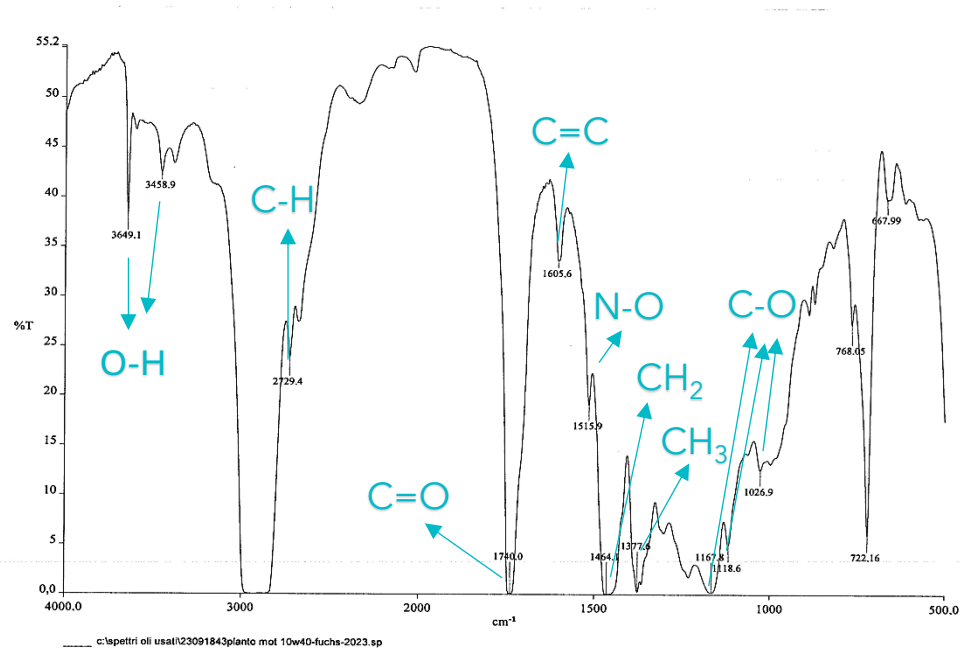


R&D – Evaluat. of Nanop. Characterization (5/6)

- Characterization and Assessment of Nanobiolubricants

FTIR Characterization of Nanobiolubricant Stability:

✓ FTIR spectra of biolubricant (PLANTO MOT SAE 10W40).



Wavelength (cm ⁻¹)	PLANTO MOT SAE 10W40	Interpretation
3649.1	Peaks present	O-H stretching (hydroxyl groups)
3458.9	Peaks present	O-H stretching (hydroxyl groups)
2729.4	Peaks present	C-H stretching (hydrocarbons or additives)
1740.0	Peaks present	C=O stretching (esters)
1605.6	Peaks present	C=C stretching (unsaturated components)
1515.9	Peaks present	N-O asymmetric stretching (additives)
1464.4	Peaks present	CH ₂ bending (hydrocarbon chains)
1377.9	Peaks present	CH ₃ bending (hydrocarbon chains)
1167.8	Peaks present	C-O stretching (esters)
1118.6	Peaks present	C-O stretching (esters)
1026.9	Peaks present	C-O stretching (esters)
768.05	Peaks present	Aromatic or unsaturated components
722.16	Peaks present	CH ₂ rocking (long hydrocarbon chains)
667.99	Peaks present	Aromatic or unsaturated components

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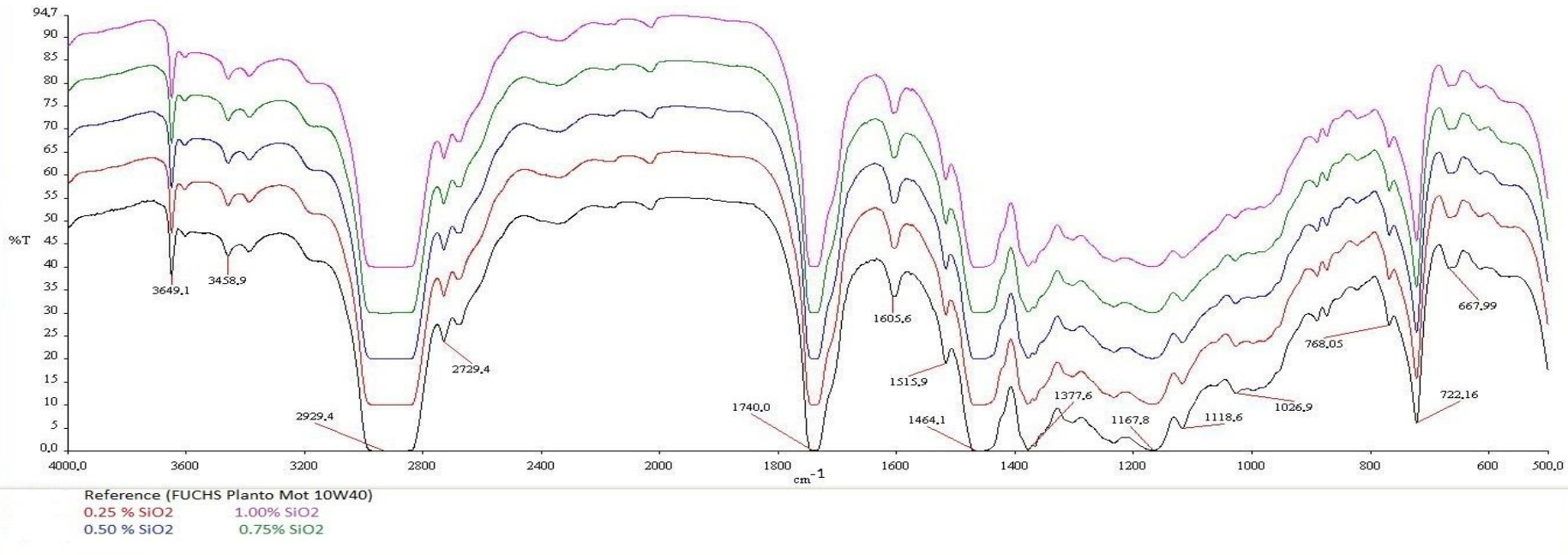


R&D – Evaluat. of Nanop. Characterization (6/6)

- Characterization and Assessment of Nanobiolubricants

FTIR Characterization of Nanobiolubricant Stability:

- ✓ FTIR spectra of reference biolubricant (PLANTO MOT SAE 10W40) and corresponding nanobiolubricants



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3



Conclusions (1/2)

Significant Findings

Enhanced Properties with SiO₂ Nanoparticles

- Surface-modified SiO₂ (via KH570) improves dispersion and stability.
- Increases density, viscosity, and viscosity index → Better thermal stability & flow resistance.
- Results: Reduced friction and wear, improved performance for industrial and automotive uses.

Chemical Stability Maintained

- No critical acidity changes (TAN, TBN).
- Minimal impact on additives, verified by ICP-OES.
- FTIR: No changes in base functional structures, indicating strong chemical stability.

Long-term Stability

- Evaluated over 77 days.
- Sedimentation visible by 30th day, more by 54th and 77th days.
- Sonication time(2.5 hrs) key to enhancing stability.



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Conclusions (2/2)

Future Research Focus

- Long-term performance tests in real-world scenarios.
- Safety and environmental impact assessments needed.



4



The End

Thank you for your kind attention



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