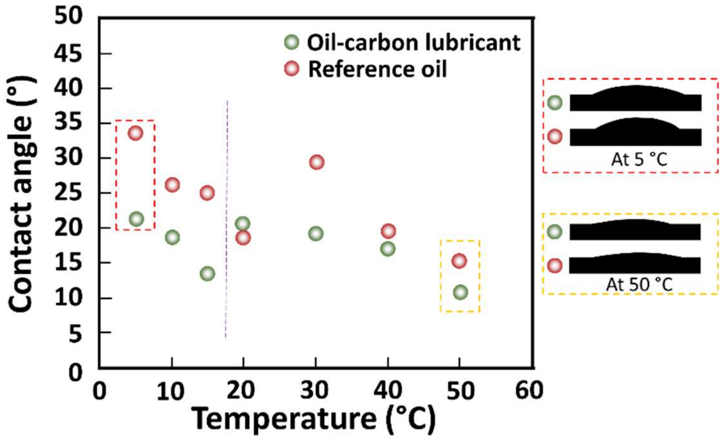
How contact angle measurements can help to enhance the performance of engine oils.

To improve the resistance to corrosion and reduce the energy loss due to friction and wear, fluid lubricants which typically contain 90% oil and 10% additives are widely used. Previous studies have shown that nanoparticles as additives help decrease the friction and wear, and improve the tribological performance of fluid lubricants. Unfortunately, two drawbacks of nanoparticles limited their application in lubricants so far—one is the formation of the larger particles due to agglomeration; the other one a poor stability due to the higher density of nanoparticles resulting in sedimentation. Especially carbon nanoparticles, which possess outstanding performance as viable oil additives, have attracted attention. A huge number of research work has been devoted to a better understanding of the tribological behavior of oil-carbon lubricants, however, very few are related to their physical and chemical properties like viscosity and wettability. Especially the wettability of oil lubricants plays an important role in their tribological behaviors making it important to study the influence of the additives on the wettability properties of baseline oil. In order to fully understand the effect of carbon nanoparticles on oil-carbon lubricant systems, Abdullah et al. have systematically studied and compared the wettability and rheological properties of oil-carbon lubricant mixture with pure baseline oil showing that oils with carbon nanoparticles have a good stability and tribological behavior as well as a good wettability.

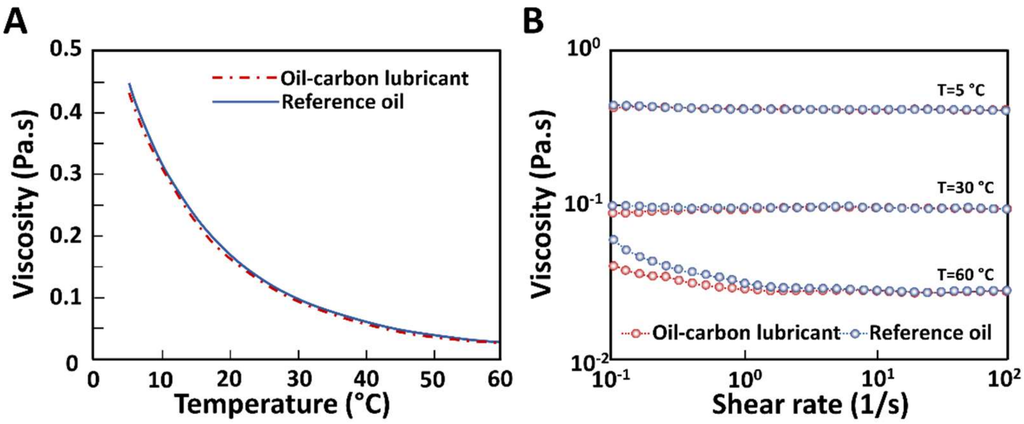
In this work, the authors first studied the morphology and size of the carbon nanoparticles by scanning electron microscopy (SEM) and dynamic light scattering (DLS), respectively. The results showed that the carbon nanoparticles have a spherical shape and smooth surface which is beneficial for lower friction and wear losses, and an average diameter of 400 nm which is suitable for reducing contact pressure by penetrating between sliding surfaces and consequently occupying asperity gaps.

They conducted contact angles (CAs) measurements on oil-carbon lubricants and reference oil, respectively, varying temperature from 5°C to 50°C. As shown in **Picture 1**, both samples possessed almost the same CAs (around 20°). When the temperature is increased the CAs of both samples decreased except for the reference oil at 30°C, which increased a bit. At 50°C, the reference oil and the oil-carbon lubricant exhibited CAs of 15° and 11°, respectively. This trend shows that the carbon nanoparticles had no negative effect on the wettability of the baseline oil. Interestingly, when decreasing the temperature (from 15°C to 0°C), the CAs of both oil samples displayed a similar increasing trend. Overall the oil-carbon lubricant had slightly lower CAs when compared to the reference oil. Because submicron-sized carbon particles with a smooth surface could fill the microstructures at the stainless-steel surface so that the surface is much smoother and thus more prone to be covered with the oils. In addition, carbon nanoparticles are more stable in oil compared to other types of nanoparticles due to their similar density with oil.



Picture 1. *Contact angles of oil-carbon lubricant and reference oil with various temperatures from 5°C to 50°C.*

Furthermore, they evaluated the viscosity and stability of the reference oil and oil-carbon lubricant. The results show that the addition of carbon nanoparticles had no effect on the rheological properties at different temperatures and shear rates (**Picture 2**). Accordingly, the addition of carbon nanoparticles will not affect the tribological performance of the oil in the hydrodynamic lubrication regime where the surfaces are separated by an oil film, which is consistent with the results in previous research. The stability of the carbon nanoparticle dispersions in baseline oil can reach 240 hours without any surfactants. Hence, above results demonstrated carbon nanoparticles as oil additives showed good stability and improved the tribological property with no influence on both the rheological and wettability properties of the baseline oil.



Picture 2. *Viscosity of oil-carbon lubricant and reference oil with (A) various temperatures and (B) various shear rates.*

Overall, this work showed us the details about the wettability properties of oil-carbon lubricants, illustrating that the addition of carbon nanoparticles has no negative influence wetting behaviors of reference oil. Moreover, carbon nanoparticles greatly improved the tribological property without changing the performance and functionality of the oil in the lubrication regimes.

An optical contour analysis system OCA (DataPhysics Instruments GmbH, Germany) was used in this research.

For more information, please refer to the following article:

Rheological and wettability properties of engine oil with a submicron spherical carbon particle lubricant mixture; Abdullah Awad Alazemi, Feras Ghazi Alzubi, Abdulsalam Alhazza, Arthur Dysart and Vilas Ganpat Pol, *International Journal of Automotive Technology* ***2020****, 21 (6), 1475-1482*; DOI: 10.1007/s12239-020-0139-z