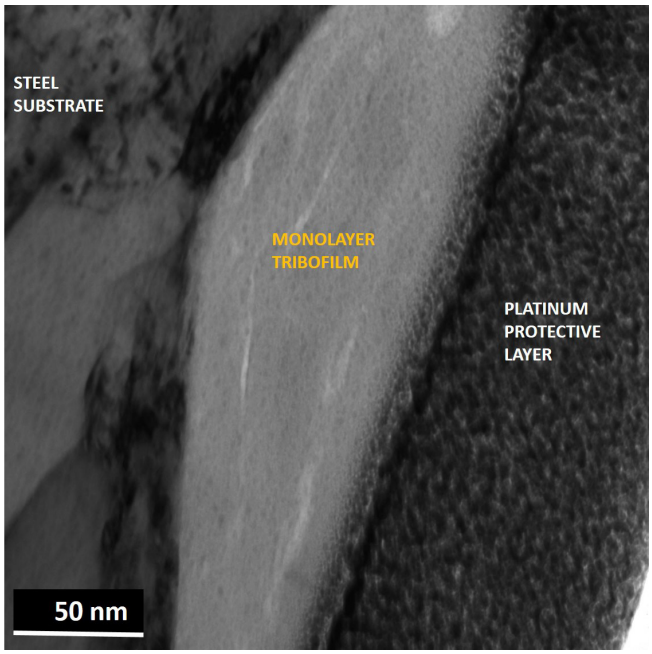
PHENOMENOLOGICAL MODELING OF LUBRICATED INTERFACE MECHANISMS

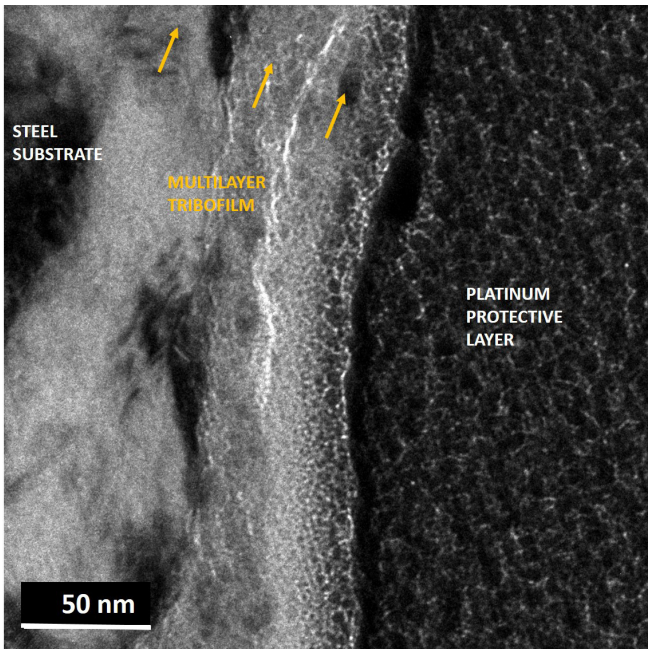
WHAT IS IT AND WHY IS IT NEEDED?

In order to achieve sustainable friction reduction and the consequent improvements in overall vehicle efficiencies, plus ensure adequate reliability and durability of lubricated components and systems, researchers and manufacturers need a better understanding of the mechanisms occurring at lubricated interfaces. Once we understand the mechanisms, we have the opportunity to develop and optimize highly fuel-efficient vehicles and systems.

WHAT IS ARGONNE DOING AND WHY?

Argonne researchers apply their expertise in the area of materials and surface science, using a suite of advanced surface and materials analytical tools to study basic mechanisms of lubrication as they relate to surface material changes and tribochemical films. The results of these studies will enable the replacement of the current Edisonian empirical approach to lubrication with a science-based mechanistic approach for sustainable friction reduction offering enhanced reliability and durability for vehicle components.





(Left) Monolayer tribochemical film. (Right) Complex multilayer tribochemical film. Both films are shown on a steel substrate that was protected with platinum for sample preparation and analysis.

WHAT HAVE WE ACCOMPLISHED?

Working in collaboration with industry and academia, the research team has:

- Developed a new technique to characterize the structure of tribochemical surface films. Established a firm correlation between the structure and the frictional behavior of the film.
  - Technique is used by other researchers worldwide.
  - Working with lubricant additive manufacturers to apply the new technique.
- Developed approach to control and modify the structure of tribochemical surface film as means to control its friction — patent pending.
- Developed and validated a predictive model for scuffing in lubricated surfaces. Scuffing is a major reliability issue, because it can cause the sudden catastrophic failure of lubricated components.
  - A partnering original equipment manufacturer uses Argonne's scuffing predictive model as a design guide in several lubricated components.
- Produced more than 15 published papers and conference presentations and one patent application.

WHERE DO WE GO FROM HERE?

Argonne's scuffing model is currently being used as a design guide for highly loaded components in vehicle systems, and several automotive OEMs are evaluating the application of that model to the piston ring and cylinder liner in internal combustion engines. Going forward, the research team will develop and evaluate new additives with predictable frictional attributes.

WHO FUNDS THE WORK?

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