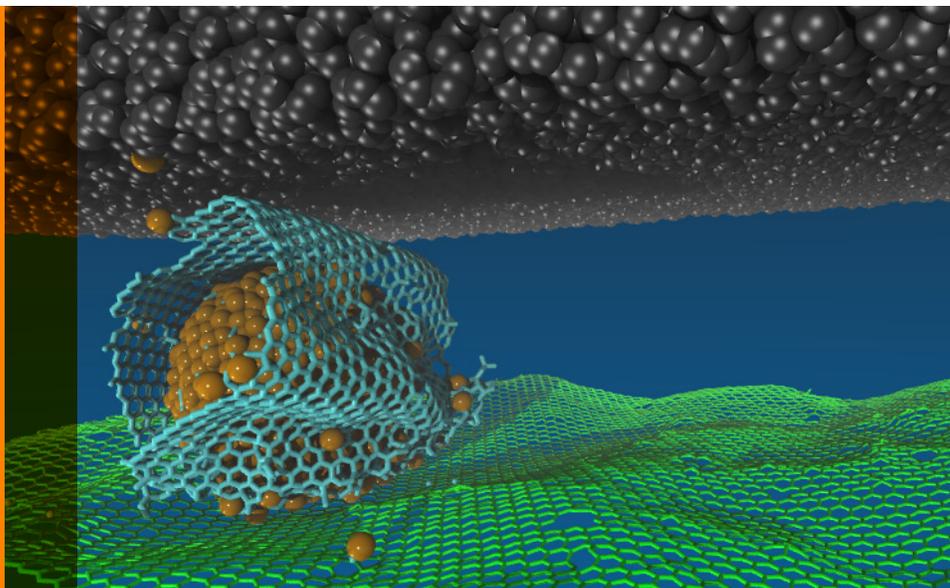


# USING NANOTECHNOLOGY TO FIGHT FRICTION AND WEAR

*Diamond and graphene “nanoscrolls” could revolutionize lubrication*



This visualization shows how Argonne researchers were able to achieve “superlubricity” through the innovative use of nanoparticles. As they rub against the black diamond-like carbon surface, the gold nanodiamond particles are wrapped up by the blue patch of graphene, creating a “nanoscroll” that reduces friction to near zero.

## CHALLENGE

Friction and wear are terrible twins that bedevil any machinery with moving parts. Approximately 30 percent of a vehicle engine’s power is sacrificed to frictional loss, and wear is a consistent destroyer of engines and other parts.

Argonne scientists have spent decades conducting cutting-edge research in tribology, seeking new ways to fight the negative consequences of friction and wear. Researchers have developed numerous types of coatings, lubricants, and additives that have greatly reduced the cost of friction.

As the bar is raised higher in the search for frictionless machines, Argonne scientists have looked to

the tiny particles of nanotechnology to finally help tame these terrible twins. Numerous solutions have been developed, but one of the more novel discoveries involves tiny diamonds wrapped in graphene that help to achieve that rarified state of “superlubricity,” a highly desirable property in which friction drops to near zero.

## SOLUTION

A team of Argonne scientists combined diamond nanoparticles, small patches of graphene—a two-dimensional single-sheet form of pure carbon—and a diamond-like carbon material to create superlubricity. As the graphene patches and diamond particles rub

up against a large diamond-like carbon surface, the graphene rolls itself around the diamond particle, creating a “scroll” that looks like a ball bearing on the nanoscopic level.

## BENEFITS

The potential benefits of superlubricity are vast, but include massive savings in energy and longer-lasting machines.

- Graphene nanoscrolls could greatly reduce frictional loss in engines, turbines, and other machines, saving energy and helping address global climate disruption through reduction in carbon emissions.
- By replacing traditional lubricants, nanoscrolls could further aid the environment by replacing petroleum-based lubricants that must be disposed of.

## APPLICATIONS

Any application that involves lubricants or ball bearings has the potential to be revolutionized by graphene nanoscrolls, including automobiles, turbines, and energy production. Argonne researchers are also investigating how nanoscrolls can be used in space, an environment that is challenging for traditional lubricants.

A. Sumant et al. *Science*. **2015**. doi:10.1126/science.1262024

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