Molecular ball bearings lube metal parts

Most people are familiar with oil's ability to grease moving parts, but some of the best lubricants used in industry today are solids, such as tungsten disulfide. As powders, these solids can be used to coat surfaces, where their slippery layers of molecules allow metal parts to slide past each other easily.

Now, a team of scientists has demonstrated that tiny, round particles of tungsten disulfide, typically 120 nanometers in diameter, make an even better lubricant than the powdered version. The particles act as miniature ball bearings, rolling to reduce friction between surfaces, says Reshef Tenne of the Weizmann Institute of Science in Rehovot, Israel. He and his colleagues at the Center for Technological Education in Holon report their findings in the June 19 NATURE.

Tenne calls the particles "inorganic buckyballs," since they take the shape of fullerene molecules but don't contain any carbon (SN: 12/5/92, p. 389). The researchers performed standard wear tests with the material, comparing it to tungsten and molybdenum disulfide powders.

Irwin L. Singer of the Naval Research Laboratory in Washington, D.C., says that the modest improvement in wear is "kind of interesting" but not large enough to convince him that the material will replace existing lubricants anytime soon. Powdered tungsten and molybdenum disulfides already work so well that "to beat them is really hard."

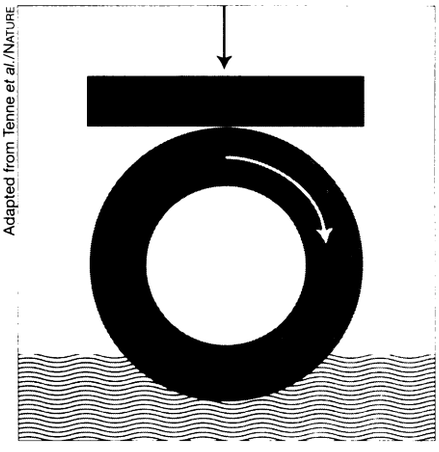
Round particles would seem to make ideal ball bearings. However, Jacob N. Israelachvili of the University of California, Santa Barbara says that "just because something rolls, it doesn't mean that it's going to be good at lowering friction." The carbon buckyballs, for example, don't reduce friction well on their own, but as Israelachvili and his colleagues recently demonstrated, they show some promise as additives to conventional liquid lubricants (SN: 8/31/96, p. 139).

Tungsten disulfide might work better than buckyballs, Tenne says, because the larger ball size increases the distance between the metal surfaces. Also, because the particles are built like onions, with up to 20 concentric layers, the particles retain their roundness even when some material wears off.

The chemical structure of the particles may also give them an advantage over powders. Unlike the powders, which take the form of flat platelets about 500 nm across, the round particles have no "dangling bonds" at the edges that can catch on metal surfaces, Tenne says. Singer notes, however, that nobody has shown whether these incomplete bonds really affect friction.

Whether the material turns out to be a practical lubricant "remains to be seen," says Israelachvili. The particles' slow wearing away suggests "a finite lifetime for these things." Lubricants for auto engines—the application targeted by Tenne's group—must last months.

The group hasn't yet done the wide spectrum of tests that would indicate whether the inorganic material will work in engines, Singer says. According to Tenne, the biggest problem the team now faces is being able to make particles in large enough quantities to perform the tests. Currently, they can only synthesize about 1 gram per day. —*C. Wu*



Adapted from Tenne *et al.*/NATURE

In one test, a metal disk circulates through a reservoir of oil mixed with spherical tungsten disulfide particles and rubs against a flat metal block. The tracks worn into the surfaces are then examined under a microscope.

Lowly status proves infectious in monkeys

Experimental disruptions of the social life of macaque monkeys have yielded intriguing, but ultimately puzzling, clues to the relationship between mind and physical health.

Primates at the bottom of the social "pecking order" display a particularly keen susceptibility to infection by a virus that causes coldlike symptoms, reports a scientific team headed by psychologist Sheldon Cohen of Carnegie Mellon University in Pittsburgh. This susceptibility cannot be attributed to such characteristics of low-status monkeys as low body weight, a penchant for submissive behavior, and declines in some measures of immune function, according to Cohen's group.

In contrast, monkeys exposed to the stress of persistent membership changes in their social groups proved no more likely to develop a viral infection than those in stable groups. This result appears to contradict previous evidence that such stress weakens immune responses in macaques (SN: 10/10/92, p. 237). It coincides, however, with indications that stressful experiences provoke and worsen symptoms in infected humans but do not alter a person's chances of getting infected in the first place.

"Social stress [in macaques] was not associated with susceptibility to infection," the researchers report in the May-June PSYCHOSOMATIC MEDICINE. "However, animals with lower social status were at higher risk than high social status animals."

Macaques provide a good animal model for researchers seeking insights into the relationship between the human immune system and psychological and social factors, the researchers add.

Cohen and his coworkers studied 60 male macaques housed in five-member groups for 15 months. Half of the monkeys were assigned at random to an unstable group, in which three or four members changed places with individuals from other unstable groups on a monthly basis. The rest of the animals lived in groups that maintained a stable membership throughout the study.

Rankings of social status for each monkey depended on the animal's ability to elicit submissive behaviors from others and on the proportion of its daily activity that involved submissive displays.

After month 9, the researchers obtained measures of immune cell function and of several stress hormones every 2 to 3 months.

At the beginning of month 15, each animal was sedated and exposed to a coldlike virus in a solution applied to its nostrils. Nasal secretions were collected 2 and 4 days later and analyzed for signs of infection.

Of the 12 monkeys ranked lowest in social status, 8 became infected, the scientists report. Infections also occurred in 4 of the 12 monkeys who were second-lowest in social status. For animals on the remaining three rungs of the social ladder, only one at each position developed an infection.

Low-status monkeys exhibited lower body weights, greater surges in stress hormones when housed in unstable groups, and drops in immune cell function. These trends could not account statistically for their surplus of infections, according to the investigators.

Further research on the monkeys may require more sophisticated measurements of hormonal and immune responses to yield a clearer picture of their relationship to social status and stress, writes psychologist Christopher L. Coe of the University of Wisconsin–Madison in an accompanying comment.

Still, the new study adds to evidence (SN: 8/31/91, p. 132) that psychological factors influence some viral infections. Coe suspects that stress may block the recruitment of immune cells to sites of infection. —*B. Bower*