PHYSICS

Hidden culprit found for puzzling static electricity

Trace surface contamination determines how identical materials exchange charge RACHEL BERKOWITZ

Static electricity sparks lightning during a 2017 volcanic eruption in Japan. How identical materials like ash exchange charge has long mystified researchers.

Some kinds of static electricity are easy to understand. Rub a balloon against your hair, and negative charges will accumulate on the rubber because it has a greater affinity for holding charges. Your hair, now positively charged, will be attracted to the balloon. And because like charges repel, strands of your hair will splay out from each other.

But identical materials with identical affinities can also exchange charges, seemingly without rhyme or reason. Particles in volcanic ash plumes somehow build up enough charge to trigger lightning; dust in grain silos can spark and explode. In a study published this week in *Nature*, researchers say they have finally found the culprit: trace amounts of surface contamination by carbon-bearing molecules from the air.

This revelation resolves "one of the bigger questions in the field, a scientific mystery that has lasted for decades," says Justin Burton, a soft matter physicist at Emory University who wasn't involved in the new work.

The major mystery of static electricity—or contact electrification, in physics parlance—is that it's impossible to predict how charge will move between different samples of a single material. After contact, one sample becomes positive and the other negative, seemingly at random. Repeat the experiment, and the sign can switch. Some researchers believe that thin coatings of absorbed water might make one sample more likely to grab charge, whereas others think microscopic differences in surface texture might play a role. But ideas are more common than answers. "We have no idea how it works, especially when it involves the same materials touching, like two sand particles," says Scott Waitukaitis, a soft matter physicist at the Institute of Science and Technology Austria. "We're literally completely clueless."

To get to the heart of the matter, Waitukaitis and his colleagues devised a hands-free apparatus that would minimize contamination. They used sound waves to levitate a tiny glass sphere above a glass plate. By briefly stopping the sound, they could bounce the sphere off the plate and catch it. Afterward, they applied an electric field to measure how much electric charge the sphere acquired in the collision—all without letting it touch any other surface. "That's where the magic lies," Waitukaitis says.

Repeating the bounce 1000 times led to a slow but steady increase of charge on the sphere. But even for clean and identically prepared samples, the sphere's charge was sometimes positive and sometimes negative—as if the material had changed between tests.

Suspecting their samples had picked up trace contamination despite all their efforts, the team took more radical steps. They baked both sphere and

PHOTO: MIKE LYVERS/GETTY IMAGES

plate at up to 300°C and used beams of ionized gas to strip off any molecules clinging to the surface. The charging rate dropped to near nothing and gradually returned to a random pattern. But when just one of the two samples was cleaned, it always picked up charge from the other sample, ending up negative. The researchers found the same behavior for a wide class of oxide materials that includes glass, sand, and many kinds of rock.

Under a microscope, the reason was clear. Samples that hadn't been baked or plasma cleaned had a patina of hydrocarbon compounds—molecules such as methyl groups and butane. Those that had been cleaned reacquired the compounds within several hours—about the same time it took the samples to resume random charging behavior. Although the researchers don't know why the molecules cause the contaminated sample to give up charge, it's clear they break the symmetry, Waitukaitis says. Before, "We couldn't even draw a picture of what was happening," he says. But now, "We know the thing that matters."

That carbon matters for static electricity on Earth means it could matter on other worlds, too. Planetary scientists have long struggled to figure out how dust in protoplanetary disks around stars clumps together and eventually grows into the embryos of planets. Gerhard Wurm, an astrophysicist at the University of Duisburg-Essen, thinks contact electrification might play an important role—and now wonders whether adsorbed molecules are part of it. The new work "proves that the organics are important in this story," he says.

They may not be the full story, however. Josh Méndez Harper, a volcanologist at Portland State University, still thinks differences in moisture could drive contact electrification. Water is everywhere, it sticks to most everything, and changing humidity leads to "wildly different" charging behaviors, he says. But surface moisture builds up fast, whereas the charge evolution that scientists tracked happens much more slowly.

Others say that for polymers, or plastics, the key factor may be nanoscale variations in surface roughness. Collisions between malleable materials "mushes" their surface features, providing an asymmetry that can drive contact electrification. Five years ago, Waitukaitis held out hope for a common mechanism that applied to all materials. Now, he says, "What matters for polymers doesn't matter for oxides, and vice versa."

That's why Daniel Lacks, a chemical engineer at Case Western Reserve University, is pessimistic that researchers will ever be able to fully predict—let alone control—contact electrification. Seemingly "invisible parameters" that are not inherent to the material end up being critical, he says. "This work is helping us get to an answer, even if it's not the answer we were hoping for." □

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GLOBAL HEALTH

United States cuts ties with WHO's cancer research arm

Influential agency may lose research projects, collaborations, and part of its annual budget **JOCELYN KAISER**

The United States's withdrawal from the World Health Organization (WHO) is having knock-on effects on an influential global organization for cancer research, *Science* has learned. The U.S. National Institutes of Health (NIH) is cutting ties with the International Agency for Research on Cancer (IARC), WHO's 60-year-old cancer research arm. The decision could spell the end of a half-dozen NIH-funded research projects and the loss of 9% of IARC's total budget.

"It's very concerning," says cancer epidemiologist Logan Spector of the University of Minnesota Twin Cities. IARC, based in Lyon, France, "is pretty central in cancer prevention, control, etiology, and registration," he says.

The move also appears likely to end long-running collaborations between IARC and the National Cancer Institute (NCI), the National Institute of Environmental Health Sciences (NIEHS), and other federal agencies. "We're trying to figure out what the process is to wind [collaborations] down in a responsible way," says NIEHS Director Kyle Walsh.

President Donald Trump announced the withdrawal from WHO in January 2025, citing China's influence on the organization and claiming WHO helped cover up the COVID-19 pandemic. The U.S. soon began to disengage from IARC as well. At least six scientists from federal agencies canceled plans to attend IARC workshops in the past year, according to IARC's website—perhaps because of Trump's restrictions on travel by federal employees.

More recently, NCI researchers canceled registrations for a May meeting where IARC will celebrate its 60th anniversary, says IARC spokesperson Véronique Terrasse. She could not say whether an NCI plenary speaker on the program, Erikka Loftfield, would still attend. Several NCI staffers confirmed on background that NIH is formally ending the institute's work with IARC. (NCI did not respond to a request for comment. A spokesperson for Secretary of Health and Human Services Robert F. Kennedy Jr. said Kennedy "will rely on the expertise of America's accomplished career scientists and public servants" instead of "unaccountable global bureaucrats.")

The prospect of losing U.S. support is sending jitters through IARC. The agency has not yet "received any official communication from the U.S. announcing a withdrawal" and cannot "speculate" about its impact, Terrasse says. But "sustained investment is … essential to support IARC's wider research activities," she adds.

IARC may be best known for its monographs, reviews of the carcinogenicity of chemicals and other types of exposure, from very hot drinks to the herbicide glyphosate. "They're probably the authoritative global reference evaluating carcinogenic hazards," says toxicologist Dave Dorman of North Carolina State University, who has served on monograph working groups. The agency also pools data from countries on cancer cases through international consortia.

IARC's annual budget, projected to be €57.6 million this year, comes partly from direct country contributions, including €1.7 million from the U.S. in 2026 that has not yet been paid. NIH provides an additional €3.4 million in grant funding, mostly through NCI, for six specific projects, including a lymphoma consortium, and an effort to detect cervical cancer in low-income countries.

The U.S. also provided a $1 million grant that funded 40% of IARC's 2025 budget for the monographs. Losing that could result in "a substantial reduction" in the four or more potential carcinogens usually assessed annually, Terrasse says. Barring federal scientists from IARC will also mean they no longer provide input for the monographs, which feed into U.S. risk assessments. "It's a decision that doesn't have any long-term benefits for the United States," Dorman says. □

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