FOOD SCIENCE

Popcorn Physics 101

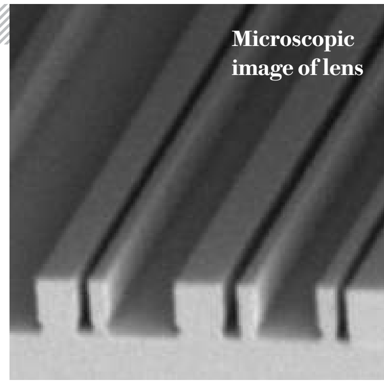
Grab some butter and salt

Americans eat more than 17 billion quarts of popcorn every year, yet some of the biomechanics of this deceptively simple treat still escape science. Most existing popcorn trivia—that 96 percent of kernels pop at 356 degrees Fahrenheit, for example—originated from commercial research, so a French physicist and aeronautical engineer took it on themselves to meticulously investigate the thermodynamic and acoustic properties of popcorn popping.

The basic journey of hard kernel to fluffy morsel is straightforward. Heat causes water inside the kernel's starchy interior to boil, building up pressure until the vapor bursts through the shell. But with high-speed cameras in hand, this team discovered something new: starch inside heated kernels first forms a leglike appendage (*right*). As the scientists described in the *Journal of the Royal Society Interface,* after the leg comes into contact with the bottom of a pan or bag, it compresses and releases like a spring, vaulting the kernel into the air and causing it to somersault. "It's quite similar to when we humans jump because we also compress our muscles and release them," says co-author Emmanuel Virot, an aeronautical engineer then at École Polytechnique.

The researchers also monitored the motions of the classic movie snack with supersensitive microphones and found that the characteristic "pop" sound typically occurs about 100 milliseconds after the kernel cracks open. Thus, the kernel's splitting is not the source of the sound. The researchers suspect instead that the pockets of heated water vapor within cause the noise as they burst through their starchy cages. These delicious results could help clarify tough physics ideas for students. As co-author Alexandre Ponomarenko, a physicist now at the French National Institute for Agricultural Research, puts it: "The aim of this research was really to provide physics teachers with a fun way to show all of these concepts in the classroom."

—*Rachel Nuwer*



MATERIALS SCIENCE

The Lens Descends

Optics, reimagined

The gently curved lentil served as the namesake for the similarly shaped lens. Future cameras, however, may focus light by relying on *flat* lenses. Physicists are making major advancements with planar lenses that can scatter and bend rays of light, sans bulge.

As we dream of smartphones that could roll up or slip into a wallet, laboratory researchers have made inroads with flexible circuits, batteries and displays. The millimeters-thick camera lens, however, stands in the way, especially in cases where corrective lenses are necessary to overcome imperfections that would otherwise yield blurry images.

A leap ahead came in 2012, when physicist and engineer Federico Capasso and his colleagues at Harvard University introduced a rudimentary flat, ultrathin lens. Despite its lack of curvature, the glass sliver could focus light via microscopic silicon ridges densely and precisely arranged to bend incoming waves in specific, calculated directions (*above*). But the lens worked on wavelengths of only one color—and not precisely at that.

The latest rendition, detailed online in February in the journal *Science,* has moved beyond proof of concept: it perfectly focuses red, green and blue light, which can be combined to yield multicolor images. The team has since crafted a larger prototype, and it "works exactly like the prediction," Capasso says. Such lenses could reduce the bulk and cost of photography, microscopy and astronomy equipment. And they could one day be printed on flexible plastic for thin, bendable gadgets. The scientists are in talks with Google and other technology companies. Such low-profile lenses would be useful for new kinds of compact, lightweight displays and imaging systems, says Bernard Kress, principal optical architect at Google[x].

The question is, If it doesn't look like a lentil, can it still be called a lens? —*Prachi Patel*

SOURCE: "POPCORN: CRITICAL TEMPERATURE, JUMP AND SOUND," BY EMMANUEL VIROT AND ALEXANDRE PONOMARENKO, IN *JOURNAL OF THE ROYAL SOCIETY INTERFACE,* VOL. 12, NO. 104; MARCH 2015 (*popcorn and somersaulting person*); COURTESY OF PATRICE GENEVET, FEDERICO CAPASSO AND FRANCESCO AIETA *Harvard School of Engineering and Applied Sciences* (*lens image*)

Graphic by Jen Christiansen