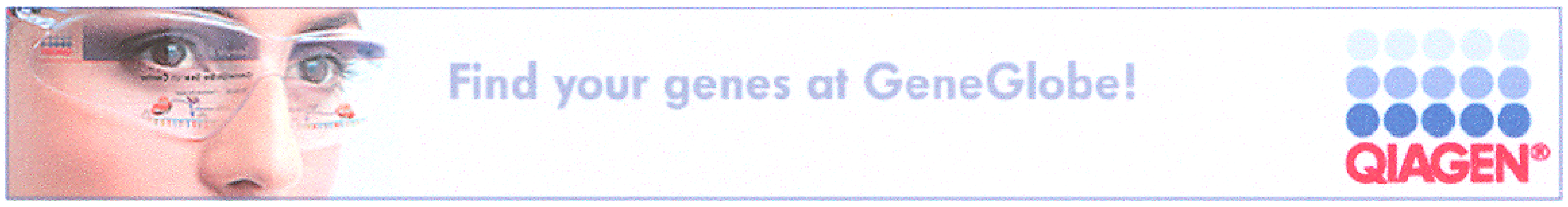

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These Materials Can't Be Stretched Thin

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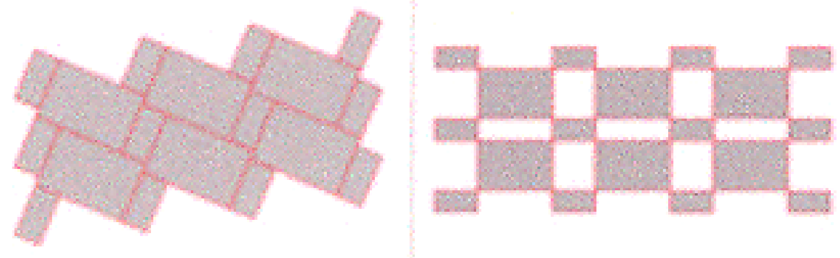

Stretched thick. A new model shows how auxetic materials expand under stress.

Credit: Joseph Grima

Imagine a rubber band that grows fatter when stretched and thinner when released. Such materials, called auxetics, actually exist, but scientists haven't totally figured out how they work. A new mathematical model may help. Researchers say the model can accurately predict the properties of these materials, opening the way for a number of applications, including bandages that dispense medication when a wound swells and earthquake-resistant building structures.

German physicist Woldemar Voigt first discovered auxetics in iron pyrite crystals (also known as Fool's Gold) nearly a century ago. His research suggested that the crystals somehow grew thicker when stretched. Voigt could not explain the strange behavior, and no practical applications existed at the time, so researchers ignored the work for decades.

Scientists began looking at auxetics again in the 1980s. Researchers had begun synthesizing materials that showed auxetic properties, such as a honeycombed polymer foam that grew fatter when pulled, and they wanted to learn how to harness the phenomenon. They imagined plumbing seals that would compress when pushed into holes and slots but that could not be pulled out; the harder you pulled, the more they would expand. Auxetics also excel at absorbing sound, vibrations, and impact, making them strong candidates for insulation, shock absorbers, and car bumpers.

In a paper published online today in the *Proceedings of the Royal Society A*, scientists at the University of Malta present an all-purpose mathematical model of auxetic behavior. The model finally unravels what happens when an auxetic material is stretched, says mathematician, chemist, and co-author Joseph Grima. It's based on one type of auxetic, a composite whose structure is represented by an array of connected rectangles and/or squares (see illustration). The model reveals that when the material is stretched, the rectangles—called rigid, rotating subunits—rotate relative to one another (see animation), lowering the material's density but increasing its thickness. Grima explains that the model can predict the auxetic potential of any material.

The model is "one of the most comprehensive depictions of auxetic behavior I have seen so far," says aerospace engineer Fabrizio Scarpa of Bristol University in the United Kingdom. He says the study could even inspire new work in diverse areas such as liquid-crystal polymers, which are used in a variety of electronic applications, and the development of foldable antennas and reflectors for spacecraft.

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