

Once in a while, new innovations remind us of the extraordinary potential of color technology. That was the case recently when a group of researchers from the University of Pennsylvania developed a dynamic new material designed to produce color shifts when hit with certain levels of force. By applying mechanochromism—the ability to change color in response to mechanical stimuli—to protective headgear, the color-shifting material could immediately detect possible injury and alert users to seek treatment. At a time of heightened concern regarding traumatic head injury as the result of amateur and professional sports, combat, and other dangerous activities, this innovative application of the mechanochromic phenomena presents new possibilities for early interventions that could ultimately save lives.<sup>1</sup>

## Moving Towards Smarter Polymers

The researchers, led by chemist Shu Yang, originally worked with holographic lithography to create photonic crystals whose colors vary with their shape to create a working model of impact-dependent color change. However, this was only the first step; due to the cost-prohibitive nature of the holographic lithography method, they then used the model to extrapolate more economically viable production methods. Further research led to the creation of polymer-based materials that could mimic the behavior of photonic crystals at significantly lower cost.

First, they molded the polymer into a structure similar to the photonic crystals. A mold is made up of mixed differently-sized particles of silica. Crystals then assembled into the desired patterns. They heated the polymer in the mold, allowed it to solidify and then removed the silica to create inversed polymer crystals.<sup>2</sup>

The specific nature of the color change measures the force of the collision, producing distinct and repeatable chromatic shifts in response to specific levels of force. For example:

One instance, when color was recorded to have changed due to force, was when they applied 30 mN to the polymer crystals which shifted from red to green. That's as strong as a sedan running at 80 miles per hour and crashing into a brick wall. With 90 mN which has a force similar to a speeding truck also hitting the same wall made the polymer crystals turn purple.

More research must be done to quantify the relationship between the force of impact and brain trauma and allow for full functionality of the material. If a fully realized mechanochromic alert system can be implemented, the ability to protect athletes, adventurers, and workers in dangerous professions will truly be revolutionized.

## Expanding the Potential of Mechanochromism

The possibilities of mechanochromic polymers aren't just theoretical; these remarkable materials are already being used in a wide assortment of applications designed to improve health and safety. Integrating mechanochromic polymers in objects prone to wear and tear can allow users to easily assess whether it needs replacing. Smart Structures Research Institute, for example, developed a climbing rope that could notify users that its level of stress exposure had rendered it unsafe for continued use and researchers in the aerospace industry have also engaged these remarkable materials to detect impending equipment failure.<sup>3</sup>

Meanwhile, tampering and [counterfeiting concerns in the pharmaceutical industry](#) have led some companies to integrate mechanochromic packaging elements that alert users to potential mishandling and manufacturers of fragile and unstable materials and substances are integrating mechanochromic warning systems to indicate overload conditions. Research is currently under way into countless other applications that will change the way we live, work, and play.

## The Highest Level of Color Quality Control

In coming years, the development of an even more diverse array of mechanochromic polymers will be necessary to meet demand as actors across industries recognize [the potential of smart materials](#). When these sophisticated plastics are deployed for critical health and safety purposes, color consistency, accuracy, and predictability are absolutely essential to ensuring optimal function. The sophisticated color measurement capabilities of spectrophotometry offer an invaluable analytical tool as researchers and manufacturers seek to develop new mechanochromic materials, both dye-based and structural. By [objectively quantifying chromatic data](#), spectrophotometers allow for precise observation of color behavior in response to specific stimuli, giving you the information you need to thoughtfully tailor polymer design, dye formulations, and usage instructions. The power of spectral analysis gives you unprecedented color management abilities to achieve the highest level of aesthetic quality and functionality in mechanochromic polymers and truly unlock the potential of these exciting materials.

Full article with photos available here:

<https://www.hunterlab.com/blog/color-plastics/exploring-how-spectrophotometry-can-help-mechanochromic-polymers-reach-their-potential/>