

# US scientists develop self-healing plastic stronger than steel

Scientists in the US have designed a carbon-fiber plastic composite that not only heals itself the way skin does, but also recovers its original shape under heat and outperforms steel in strength.

The new recyclable material, an advanced carbon-fiber plastic composite called Aromatic Thermosetting Copolyester (ATSP), was developed by researchers at Texas A&M University and the University of Tulsa.

Funded by the US Department of Defense and led by Mohammad Naraghi, PhD, director of the nanostructured materials lab and professor of aerospace engineering at Texas A&M, the research paves the way for transformative applications in the defense, aerospace, and automotive industries.

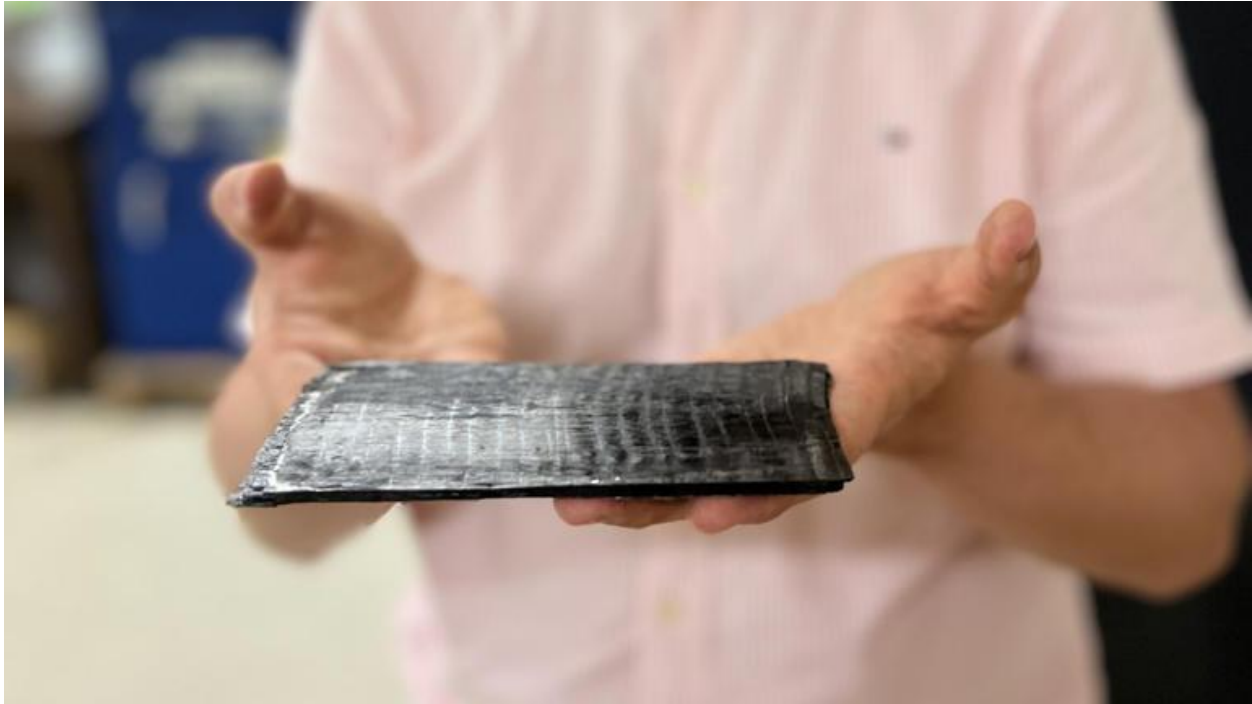
“What’s really exciting is that this material isn’t just ultra-durable – it’s also adaptive,” Naraghi said. “From on-demand healing in damaged aircraft to enhancing passenger safety in vehicles, these properties make it incredibly valuable for future materials and design innovations.”

## A self-repairing solution

ATSP’s unique [bond-exchange chemistry](#) enables components to repair cracks and deformations by simply applying heat, thus restoring them to near-original strength, or even improving it.

As per Naraghi, extreme stress and [high temperatures](#) can lead to dangerous material damage in aerospace applications. When this damage affects a critical part of an airplane, crews can use on-demand self-healing to restore its function.

The technology also holds promise for improving safety design in cars. It can reportedly restore a car’s shape after a collision and, more importantly, greatly improve safety by protecting passengers.



Mohammad Naraghi, PhD, showcasing ATSP, the carbon-fiber smart plastic. Image credit: Dr. Mohammad Naraghi/Texas A&M University College of Engineering

The material is recyclable and a more sustainable alternative to [traditional plastics](#). Its chemistry remains stable over multiple reshaping cycles, making it a strong candidate for reducing waste without compromising reliability.

“ATSPs are an emerging class of vitrimers that combine the best features of traditional plastics,” Naraghi elaborated, adding that they fuse thermoplastic flexibility with thermoset stability. “So, when combined with strong carbon fibers, you get a material that is several times stronger than steel, yet lighter than aluminum.”

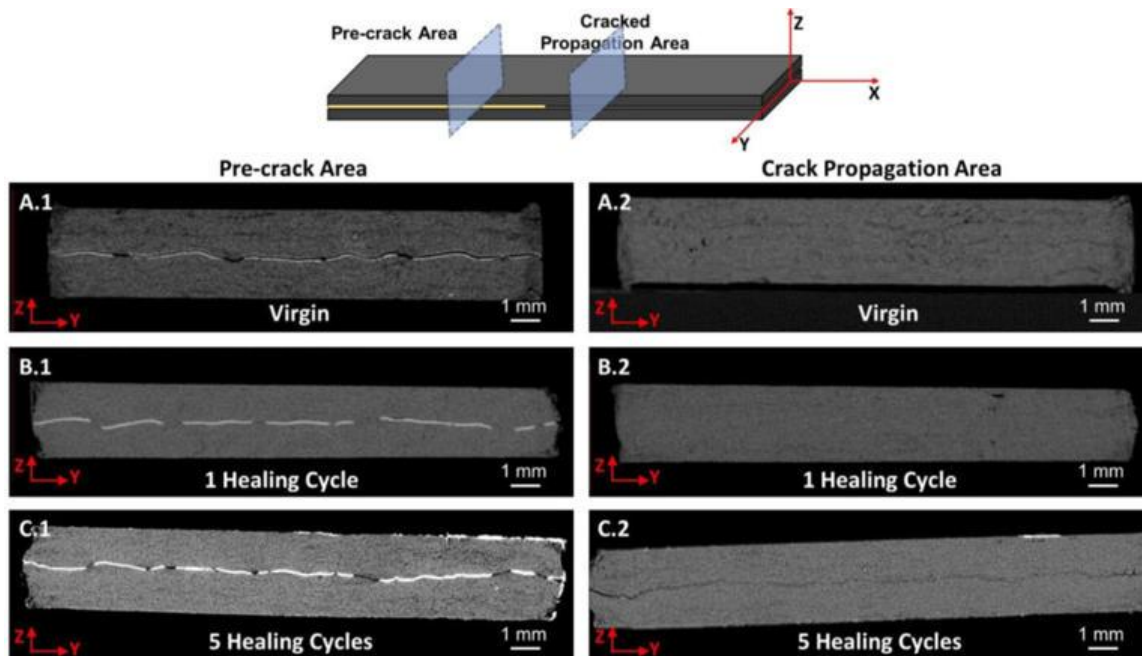
When reinforced with discontinuous fibers, vitrimers, a [class of plastic](#), can be reshaped repeatedly, crushed, and molded into new forms many times without their chemical structure degrading.

## Testing the waters

To investigate ATSP’s self-healing and shape-shifting capabilities, the researchers tested cyclical creep by repeatedly stretching and releasing the material while measuring how it stored and released strain energy.

Using cyclical loading, they identified two critical temperatures, the first one being the glass transition temperature, where polymer chains move freely. The second one was the vitrification temperature, where bonds become active enough to enable healing, reshaping, and recovery.

During one trial, they heated the composite to around 320 degrees Fahrenheit (160 degrees Celsius) to trigger shape recovery. The results showed that ATSP samples endured hundreds of stress and heating cycles without failure and became more durable during healing.



X-ray images of ATSP across five different damage-healing cycles. Image credit: Dr. Mohammad Naraghi/Texas A&M University

In another experiment, they exposed damaged samples to 536 degrees Fahrenheit (280 degrees Celsius) after stress testing. After two full damage-healing cycles, the material returned to nearly full strength. By the fifth cycle, healing efficiency declined to about 80 percent due to mechanical fatigue from manufacturing defects. Chemical stability, however, remained intact.