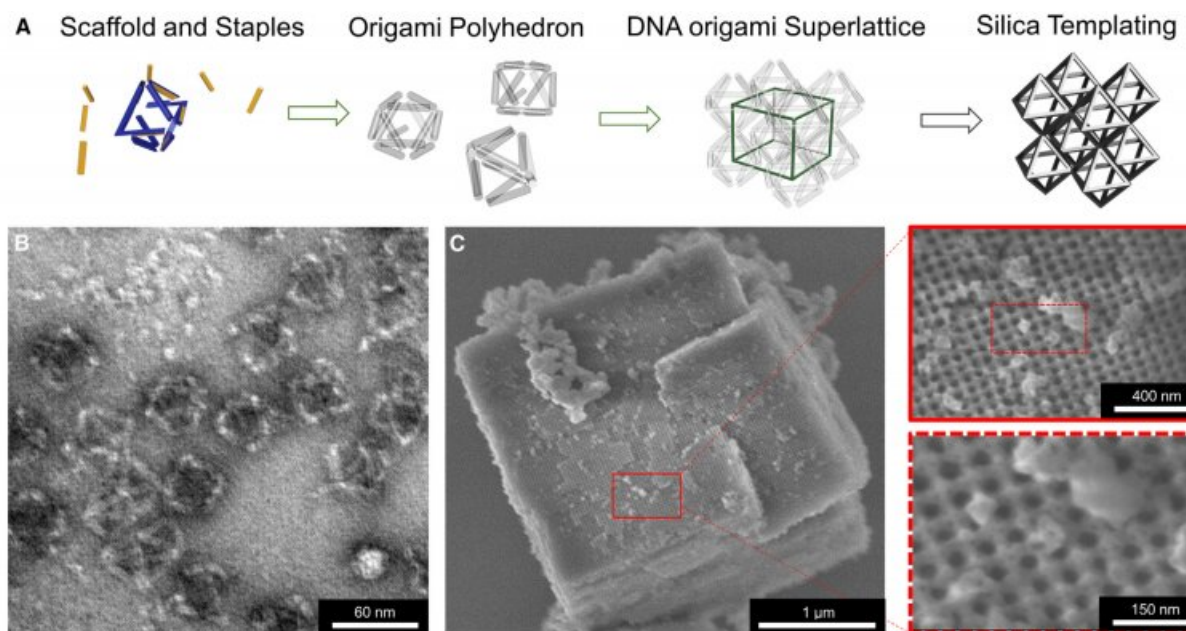


# Researchers build a DNA structure and coat it with glass, creating a very low density, very strong material

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Materials scientists from UConn and Brookhaven National Laboratory built an exceptionally strong, lightweight material out of DNA and glass. The series of images at the top (A) show how the skeleton of the structure is assembled with DNA, then coated with glass. (B) shows a transmission electron microscope image of the material, and (C) shows a scanning electron microscope image of it, with the two right-hand panels zooming in to features at different scales. Credit: University of Connecticut

Materials that are both strong and lightweight could improve everything from cars to body armor. But usually, the two qualities are mutually exclusive. Now, University of Connecticut researchers and colleagues have developed an extraordinarily strong, lightweight material using two unlikely building blocks: DNA and glass.

"For the given density, our material is the strongest known," says Seok-Woo Lee, a materials scientist at UConn. Lee and colleagues from UConn, Columbia University, and Brookhaven National Lab reported the details on July 19 in *Cell Reports Physical Science*.

Strength is relative. Iron, for example, can take seven tons of pressure per square centimeter. But it's also very dense and heavy, weighing 7.8 grams/cubic centimeter. Other metals, such as titanium, are stronger and lighter than iron. And certain alloys combining multiple elements are even stronger. Strong, lightweight materials have allowed for lightweight body armor, better medical devices and made safer, faster cars and airplanes.

The easiest way to extend the range of an electric vehicle, for example, is not to enlarge the battery but rather make the vehicle itself lighter without sacrificing safety and lifetime. But traditional metallurgical techniques have reached a limit in recent years, and materials scientists have had to get even more creative to develop new lightweight high strength materials.

Now, Lee and colleagues report that by building a structure out of DNA and then coating it with glass, they have created a very strong material with very low density. Glass might seem a surprising choice, as it shatters easily. However, glass usually shatters because of a flaw—such as a crack, scratch, or missing atoms—in its structure. A flawless cubic centimeter of glass can withstand 10 tons of pressure, more than three times the pressure that imploded the Oceangate Titan submersible near

the Titanic last month.

It's very difficult to create a large piece of glass without flaws. But the researchers knew how to make very small flawless pieces. As long as glass is less than a micrometer thick, it's almost always flawless. And since the density of glass is much lower than metals and ceramics, any structures made of flawless nano-sized glass should be strong and lightweight.

The team created a structure of self-assembling DNA. Almost like Magnatiles, pieces of DNA of specific lengths and chemistry snapped themselves together into a skeleton of the material. Imagine the frame of a house or building, but made of DNA.

Oleg Gang and Aaron Mickelson, nanomaterials scientists at Columbia University and Brookhaven's Center for Functional Nanomaterials, then coated the DNA with a very thin layer of glass-like material only a few hundred atoms thick. The glass only just coated the strands of DNA, leaving a large part of the material volume as empty space, much like the rooms within a house or building.

The DNA skeleton reinforced the thin, flawless coating of glass making the material very strong, and the voids constituting most of the material's volume made it lightweight. As a result, glass nanolattice structures are four times higher strength but five times lower density than steel. This unusual combination of lightweight and high strength has never been achieved before.

"The ability to create designed 3D framework nanomaterials using DNA and mineralize them opens enormous opportunities for engineering mechanical properties. But much research work is still needed before we can employ it as a technology," says Gang.

The team is currently working with the same DNA structure but substituting even stronger carbide ceramics for glass. They have plans to experiment with different DNA structures to see which makes the material strongest.

Future materials based on this same concept have great promise as energy-saving materials for vehicles and other devices that prioritize strength. Lee believes that DNA origami nanoarchitecture will open a new pathway to create lighter and stronger materials that we have never imagined before.

"I am a big fan of Iron Man movies, and I have always wondered how to create a better armor for Iron Man. It must be very light for him to fly faster. It must be very strong to protect him from enemies' attacks. Our new material is five times lighter but four times stronger than steel. So, our [glass nanolattices](#) would be much better than any other structural [materials](#) to create an improved armor for Iron Man."

**More information:** Aaron Michelson et al, High-strength, lightweight nano-architected silica, *Cell Reports Physical Science* (2023). [DOI: 10.1016/j.xcrp.2023.101475](#)

Provided by University of Connecticut

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