

## European Solar Energy Storage

# Energy storage in elastic rod bending



## Overview

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Can twisted rods store mechanical energy?

Scientists have discovered a new way to store mechanical energy using twisted rods in specially designed metamaterials, delivering massive energy density gains and big potential for robotics and machines. Credit: SciTechDaily.com.

How does bending a spring affect energy storage?

Inside the spring, stress remains low, making it inefficient for energy storage. But by twisting a rod instead of bending it, the surface experiences more uniform stress, and the volume of low-stress interior material is reduced.

Can a rod store energy without breaking it?

“At first, we detected a mechanism for storing a high amount of energy in a simple round rod without breaking it or deforming it permanently,” says Gumbsch. “By defining a clever arrangement of the rods, we then integrated this mechanism into a metamaterial.”

What are mechanical metamaterials with a high elastic energy density?

An international research team coordinated at KIT (Karlsruhe Institute of Technology) has developed mechanical metamaterials with a high elastic energy density. Highly twisted rods that deform helically provide these metamaterials with a high stiffness and enable them to absorb and release large amounts of elastic energy.

Does twisting a rod reduce stress?

But by twisting a rod instead of bending it, the surface experiences more uniform stress, and the volume of low-stress interior material is reduced. Pushing this idea further, the researchers used intense torsion to induce a complex helical buckling pattern, maximizing energy storage while maintaining structural integrity.

## Do twisted rods deform helically?

Highly twisted rods that deform helically provide these metamaterials with a high stiffness and enable them to absorb and release large amounts of elastic energy. The researchers conducted simple compression experiments to confirm the initial theoretical results. Their findings have been published in the science journal Nature.

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### Twisted Metamaterial Rods Can Store Massive Amounts of Energy

Researchers have developed new twisted mechanical metamaterials that have an exceptionally high elastic energy storage capacity. They could be used for high-performance shock absorption, dampening or in robotics.

### Metamaterial Marvels: Highly Twisted Rods Unlock Large Energy Storage

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### Energy-minimizing configurations for an elastic rod with self ...

We study self-contact configurations of elastic rods by adding a repulsive energy to the bend, twist, shear, and stretch energies of a classical elast...

## Metamaterials: High-Energy Storage with Twisted Rods

Twisted rods: A Novel Approach to Energy Storage The research team, coordinated at KIT, has achieved a breakthrough by developing mechanical metamaterials that utilize highly twisted rods, deforming in a spiral to achieve both high rigidity and the capacity to absorb and release meaningful amounts of elastic energy.



## 160x More Power From a Twist: The Metamaterial

But by twisting a rod instead of bending it, the surface experiences more uniform stress, and the volume of low-stress interior material is reduced. Pushing this idea further, the researchers used intense torsion to induce a complex helical buckling pattern, maximizing energy storage while maintaining structural integrity.

## Highly twisted metamaterial rods store large amounts of energy

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## Metamaterials: Highly Twisted Rods Store Large ...

An international research team coordinated at



KIT (Karlsruhe Institute of Technology) has developed mechanical metamaterials with a high elastic energy density. Highly twisted rods that deform helically provide these ...

## Twist-Induced Snapping in a Bent Elastic Rod and Ribbon

In this study, we reveal the mechanism by which the elastic energy of an anisotropic rod is stored and rapidly released by geometric twist-bend coupling. The illustration of this phenomenon is easy.



## 160x More Power From a Twist: The Metamaterial

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## Geometric aspects of discrete elastic rods Max Wardetzky ...

What this is about Elastic rods are curve-like elastic bodies that have one dimension (length) much larger than the others (cross-section). Their elastic energy breaks down into three contributions: stretching, bending, and twisting. Stretching and bending are captured by the deformation of a space curve called the



centerline, while twisting is captured by the rotation of ...



## Metamaterials: Highly Twisted Rods Store Large Amounts of Energy ...

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## Energy storage in elastic rod bending

The energy required to bend an elastic rod is calculated using the formula  $E = 1/2 * k * x^2$ , where E is the energy, k is the stiffness of the rod, and x is the amount of deflection.



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