METAL RUBBER

(Twist it, stretch it double, fry it to 200°C, douse it with jet fuel—the stuff survives)

Steve Krar

As with the Sphinx riddle of Greek mythology, "What creature walks upon four feet in the morning, upon two at noon, and upon three at night" (answer at end of article). Nanotechnology, although in its infancy, may be puzzling but has the potential of changing how we live, work, and play.

Nanotechnology

The marriage of chemistry and engineering called **Nanotechnology** is ushering in an era of self-replicating machinery and self-assembling consumer goods made from cheap raw atoms. Nanotechnology is molecular manufacturing or building things one atom or molecule at a time with programmed nanoscopic robot arms. The trick is to move atoms individually and place them exactly where they are needed to produce the desired structure.

Using nanotechnology, researchers at Virginia-based NanoSonic have developed a new material called Metal Rubber that can conduct electricity as well as a bar of steel and stretch to three times its length. The technology could lead to everything from more flexible article limbs, to aircraft wings with more give, to bendable circuits that make a laptop or cellphone more durable.

What is Metal Rubber

Metal Rubber is a plastic polymer imbedded with metal ions, and one of the "nano-advantages," as Dr. Richard Claus says, is that it only needs around one percent of metal content to make it conductive -- allowing the material to maintain elasticity, and keeping the costly metal component low.

What makes Metal Rubber unique is not only that it combines such diverse properties, but also that it puts them together in a thicker, more usable real-world material -- not just a thin coating. Since its inception in 1998, NanoSonic has focused on creating new materials through molecular self-assembly. By alternately depositing molecules with a positive or negative electric charge on a substrate such as glass or plastic, these tiny building machines can layer together a new material that draws from different substances on a molecular level.

Metal Rubber Qualities

Terrible, horrible things can be done to this millimeters-thick patch of shimmering material crafted by chemists at NanoSonic in Blacksburg, Virginia.

- Twist it, stretch it double, fry it to 200°C, douse it with jet fuel—the stuff survives.
- After the torment, it snaps like rubber back to its original shape, all the while conducting electricity like solid metal. “Any other material would lose its conductivity,” says Jennifer Hoyt Lalli, NanoSonic’s director of nanocomposites.

Industry Interest

Metal Rubber’s properties make it unique in the world of material chemistry. As a result, the company’s has received calls from companies and government agencies eager to test Metal Rubber’s use in everything from artificial muscles to smart clothes to shape-shifting airplane wings.

Metal Rubber will probably appear first in more humble, practical roles. Abuse-resistant flexible circuits and wires, for instance, could allow you to do terrible, horrible things to your portable electronics—consequence-free. Although shape-shifting aircraft wings and sensory robotic gloves are on the horizon, "You can heat it. You can freeze it. You can stretch it. You can douse it with jet fuel."

The Manufacturing Process

The manufacturing process, called electrostatic self-assembly, starts with two buckets of water-based solutions—one filled with positively charged metallic ions, the other with oppositely charged elastic polymers. The material is repeatedly dipped into positively charged and negatively charged solutions. The positive and negative charges bond, forming layers that conduct electricity.

- The robot dips a charged substrate (glass, for example) alternately from one bucket to the next.
- The dipping slowly builds up tight, organized layers of molecules, bonded firmly by opposing charges.

Electricity flows through metal rubber because there are little metal particles, and the electricity flows from little metal particle, to little metal particle, to little metal particle, between the two ends just like a piece of copper metal," says Dr. Claus of NanoSonic.

Scientists are looking into uses of metal rubber like bendy, electrically charged aircraft wings and artificial muscles -- and wearable computers. Abuse-resistant, flexible circuits, like

cell phones, are still years away, but the future looks bright -- and powerful -- for bendable products.

Future Application of Metal Rubber: Flexi-Computers

Many companies already see industrial and commercial applications for the unique properties of Metal Rubber.

- It could be used to replace the traditional flex cable (known to break with extended usage) which is present in many mobile phones and laptops today. Metal Rubber's application in consumer electronics is also seen by many large companies as a replacement for today's circuits.
- Because of its flexibility, Metal Rubber is also a step closer towards ultraportable computers and wearable electronics.
- There are moves to use Metal Rubber in the manufacture of artificial muscles; artificial muscles react - they flex and change their shape - when they are stimulated by electricity similar to biological muscles.
- Some Companies are beginning to experiment with Metal Rubber to build artificial muscles and astronomical mirrors, and reports say aircraft companies are hoping to build aircraft wings that will flex with atmospheric conditions.

Answer to the Sphinx Riddle

Humans – In the morning of life or babyhood, humans creep on hands and knees; at noon or in manhood, humans walk erect; and in the evening or in old age, humans support themselves with a cane.