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Shape-Shifting Antennas on the Horizon

February 1, 2010

Antennas are used by everything from mobile phones to satellite television receivers to GPS devices. Now, researchers at North Carolina State University are pushing antenna design in a new direction by creating shape-shifting antennas for use in fields ranging from public safety to military applications.

Most existing antennas are made from copper or other metals, but there are limits as to just how far--and how often--they can be bent before they snap. NC State scientists have created antennas that are based on an alloy that can be bent, stretched, cut and twisted before returning to its original shape, says Michael Dickey, the research team leader and an assistant professor of chemical and biomolecular engineering at NC State.

The new antenna consists of liquid metal injected into elastomeric microchannels. Since the antennas' mechanical properties are dictated by the base alloy and not the metal, they can be easily twisted and bent to meet specific design and usability needs. The researchers make the new antennas by injecting an alloy--comprised of the metals gallium and indium--that remains liquid at room temperature. The alloy is injected into very small channels approximately the width of a human hair. The channels are hollow, like a straw, with openings at either end, but can be any shape. Once the alloy has filled the channel, its surface oxidizes, creating a "skin" that holds the alloy in place while allowing it to retain its liquid properties.

"Because the alloy remains a liquid," Dickey says, "it takes on the mechanical properties of the material encasing it." In one experiment, the researchers injected the alloy into elastic silicone channels, creating wirelike antennas that were resilient and could be manipulated into a variety of shapes. "This flexibility is particularly attractive for antennas, because the frequency of an antenna is determined by its shape," Dickey says. "So you can tune these antennas by stretching them."

The new alloy paves the way for a host of novel antenna applications. An antenna in a flexible silicone shell could be used, for instance, be used to monitor civil construction projects, such as bridges. As the bridge expands and contracts it would also stretch and shrink the antenna, changing its frequency and giving civil engineers important clues about the bridge's conviction.

Flexibility and durability are also ideal characteristics for military equipment, since the antenna could be folded or rolled up into a small package for deployment and then unfolded again without any impact on its function. Dickey thinks these new applications are the most likely uses for the new antennas, since the alloy is more expensive than the copper typically used to make the antennas that are inside or connected to consumer electronics products.

Dickey's lab is performing further research under a National Science Foundation grant in an effort to better understand the alloy's properties and to find new ways of utilizing the material to create useful devices.

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