Reconfigurable Waterbomb Antenna

CNF Project Number: 2851-19
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Primary Source(s) of Research Funding:

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Primary CNF Tools Used: AJA Sputter Deposition

Abstract:

Up to this point, our research has focused on the materials and mechanisms for dynamic actuation of waterbomb antenna structures. Specifically, we focused on the selection of materials for foldable liquid metal (LM) joints to maintain conductivity between faces. Due to the demand for integrating multiple wireless standards into a single wireless platform, a reconfigurable antenna, also known as a tunable antenna, is attracting much attention. In mechanically reconfigurable antennas, the antenna structures consist of movable parts. In order to enable the electrical operation and mechanical reconfiguration, the antenna pieces are connected by foldable joints. In this project, an elastomer joint filled with LM was used to connect the waterbomb antenna pieces (see Figure 1a and 1b).

Summary of Research:

LMs such as gallium (Ga), eutectic gallium-indium alloy (EGaIn), or gallium-indium-tin alloy (Galinstan) are intrinsically stretchable (Dickey et al., 2008). However, Ga atoms from EGain spontaneously penetrate from the EGaIn to the region of the metal pad of the antenna. Moreover, it decreases the conductivity of the metal. It is possible to prevent penetration by using a thin metal layer that serves as a sacrificial layer.

The sacrificial layer absorbs the Ga atoms from EGaIn and traps them within. Ga atoms cannot transfer to the next metal layer (the thick copper layer of the antenna), preventing it from being damaged.

We used a sputtered 100 nm Au layer (sacrificial layer) above a 20 nm Cr layer (adhesion layer) to provide penetration protection. To investigate the durability against repetitive folding and releasing, the resistance of the joint was measured during cyclic bending (1,000 cycles of 45° bending angle) (see Figure 1c). The resistance remains almost constant throughout this test.

Mechanically reconfigurable waterbomb antennas were demonstrated by connecting eight waterbomb antenna pieces using eight foldable joints. An external force can control the folding angle of the waterbomb antenna, and the structure is tunable (see Figure 1d).

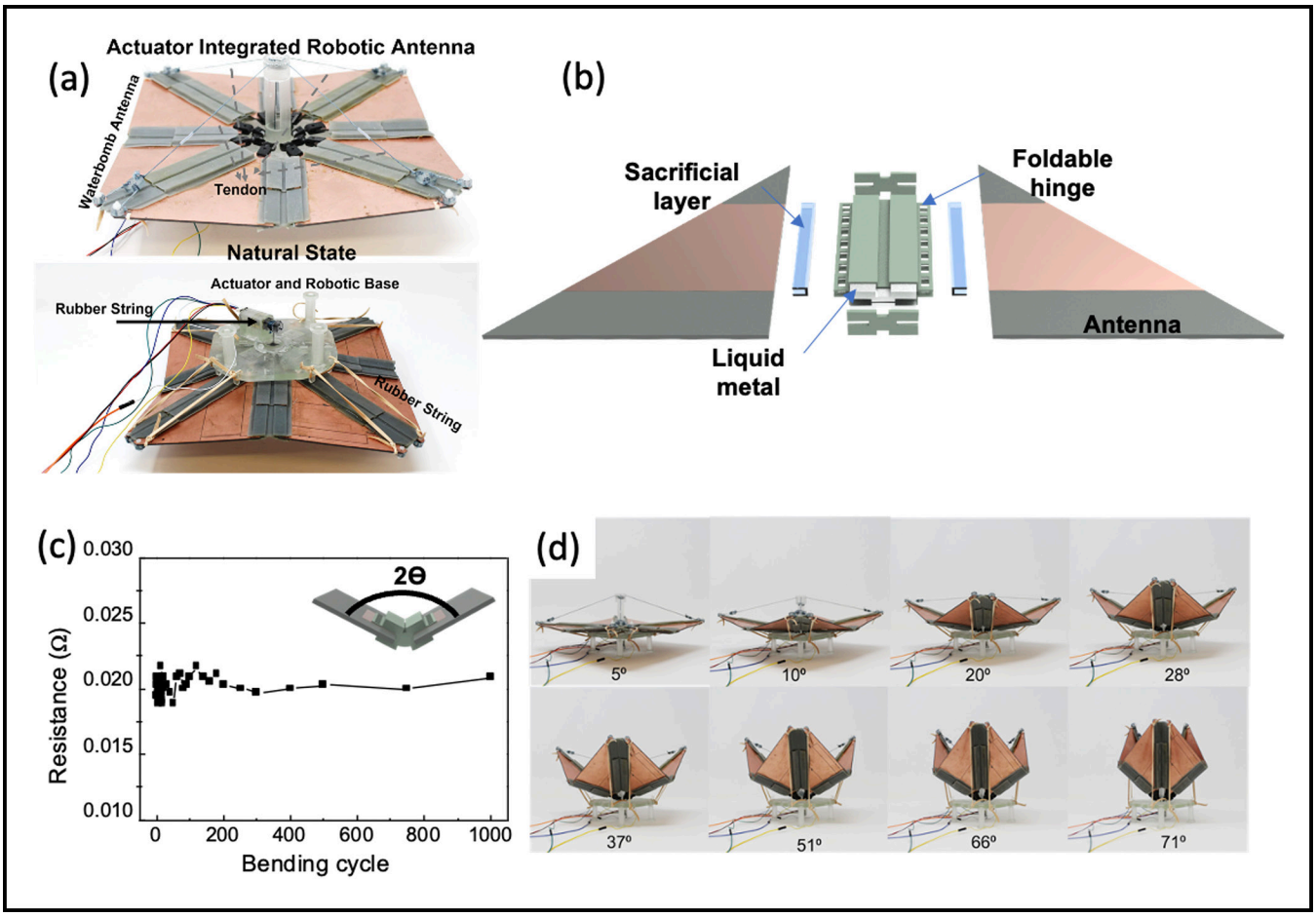

Figure 1: (a) Photograph of the waterbomb antenna. (b) Schematic image of two waterbomb pieces and a foldable joint. (c) Bending cyclic test (bending angle: 45°). (d) Photographs of the waterbomb antenna with the different folded states.