Supporting Information

Silver-Coated Poly(dimethylsiloxane) Beads for Soft, Stretchable, and Thermally Stable Conductive Elastomer Composites

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S1 Antenna Design and Simulation

Our objective is to design antennas that resonate at desired frequencies and have high reflective performance. Doing so requires carefully tuning of the antenna dimensions. We used ANSYS HFSS to simulate the antenna properties at zero strain, including the resonant frequency, S11 parameter, Z parameter and antenna gain. We set the relative permittivity of PDMS to 3.11 and the bulk electrical conductivity of the antenna composite to 2100 S/cm for the simulations. The input geometry of device for the HFSS simulation, i.e. the dimension of antenna and surrounding dielectric layer (PDMS), is shown in **Figure S9**. We find excellent agreement between experimental results and simulation output (Figure 4a) at zero strain, which indicates the great potential of ANSYS HFSS in designing antenna made from PDMS@Ag/Ag flake/PDMS PS3 composite.

For the smart furnace glove application, we use a commercial RFID signal reading system consisting of a far field RFID antenna (LHCP far field RFID antenna, Impinj) and reader system (speedway revolution R240 UHF RFID reader, Impinj) to read the signal strength of RFID tags through RFID chips. This reading system has scanning frequency from 0.902 GHz to 0.928 GHz. Thus, based on the same simulation solver (HFSS), we let the RFID system have a resonant frequency of 0.929 GHz by designing a serpentine dipole antenna with a loop (**Figure S10**). We used a serpentine layout instead of a linear trace for antenna to reduce the length of the whole RFID tag so that it could fit into the glove fingers.

S2 Supporting Figures

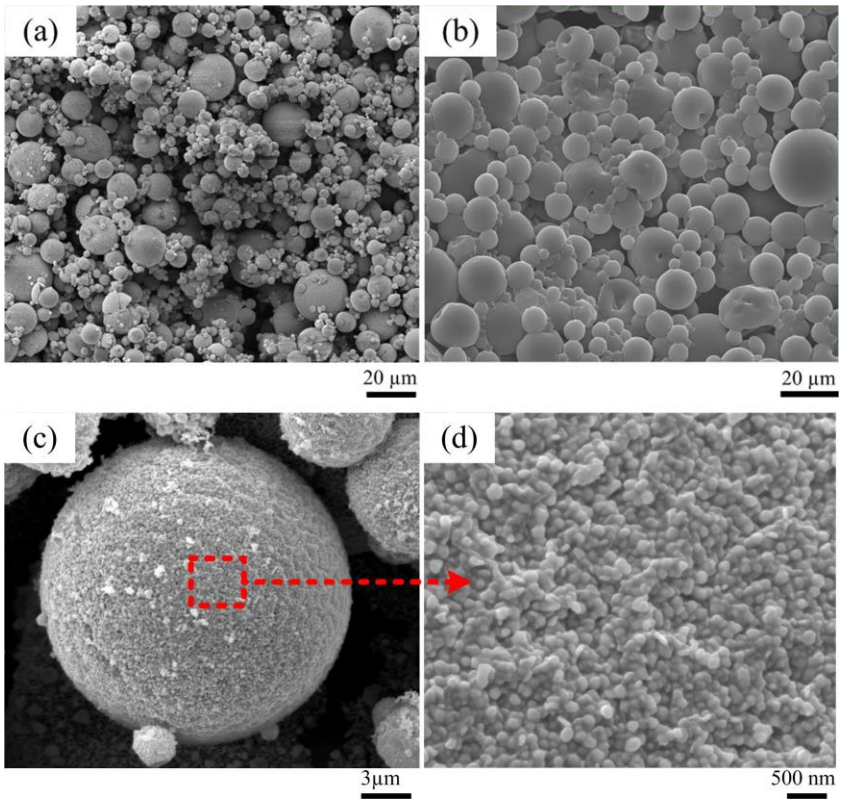

Figure S1 (a) Scanning electron microscope (SEM) image of polydisperse core-shell PDMS@Ag particles, (b) polydisperse PDMS particles, (c) single core-shell PDMS@Ag particle, and (d) zoomed-in image of Ag shell.

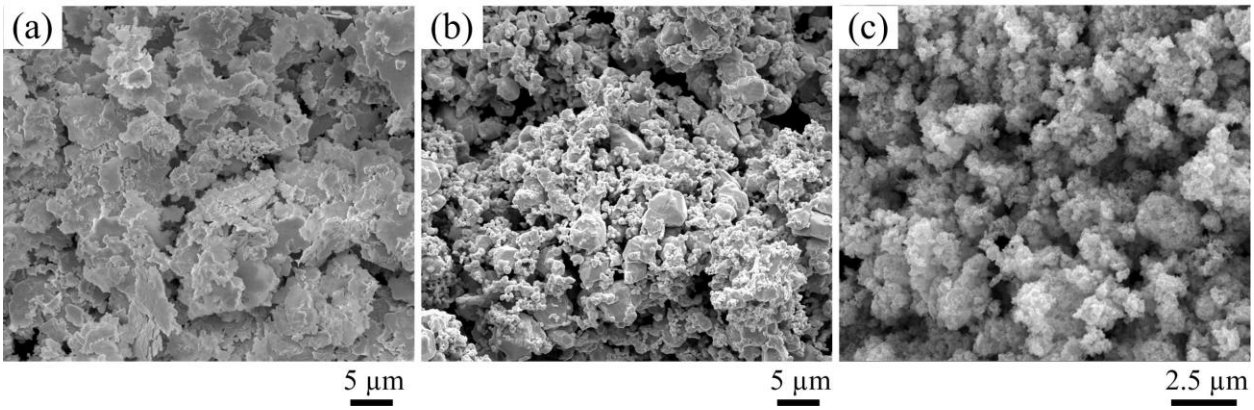

Figure S2. SEM image of Ag fillers: (a) Ag flakes, (b) Ag microparticles, and (c) Ag nanoparticles

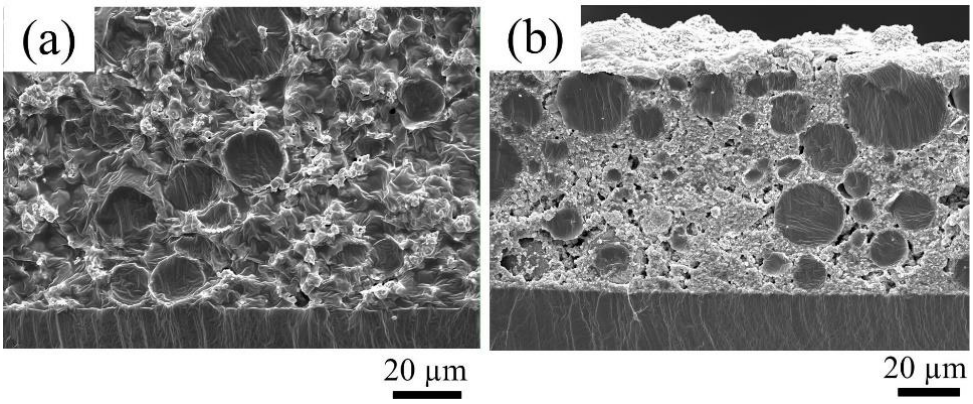

Figure S3. SEM image of sample cross sections: (a) PDMS@Ag/Ag microparticle/PDMS, and (b) PDMS@Ag/Ag nanoparticle/PDMS PS3 composite.

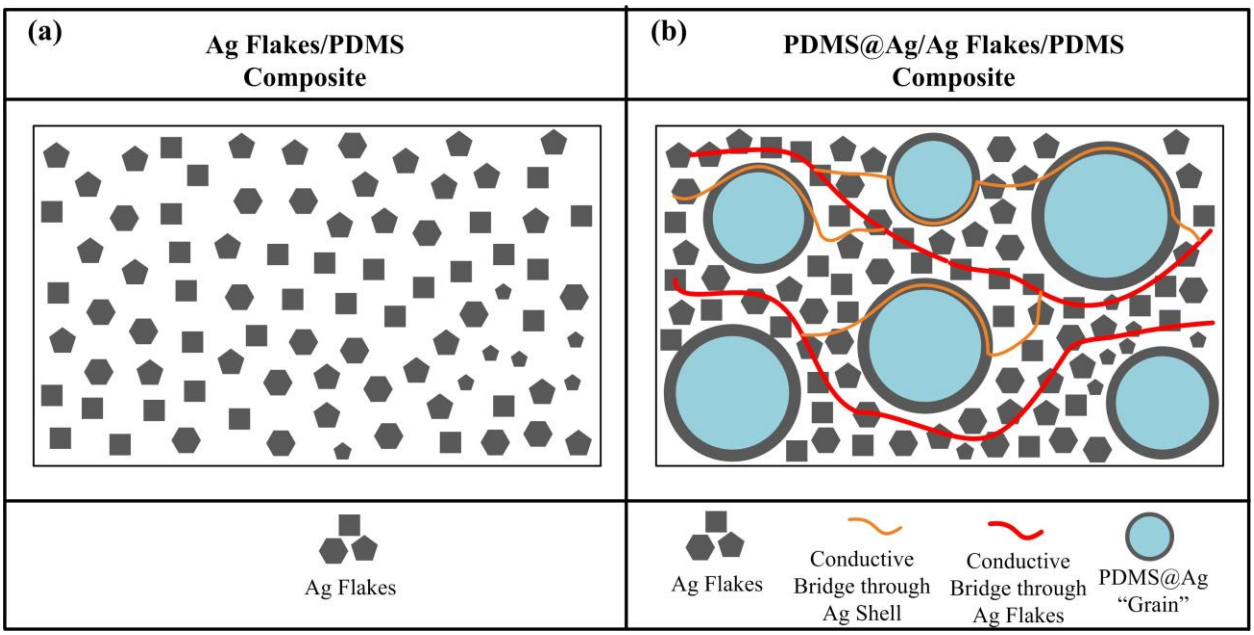

Figure S4. 2D Schematic illustration of the comparison between: (a) Ag flakes/PDMS, and (b) PDMS@Ag/Ag Flake/PDMS PS3 composite. PS3 composite shows phase segregation of Ag flakes between "grains" (denser Ag flakes) and two types of conductive pathways helping enhancement in electrical conductivity.

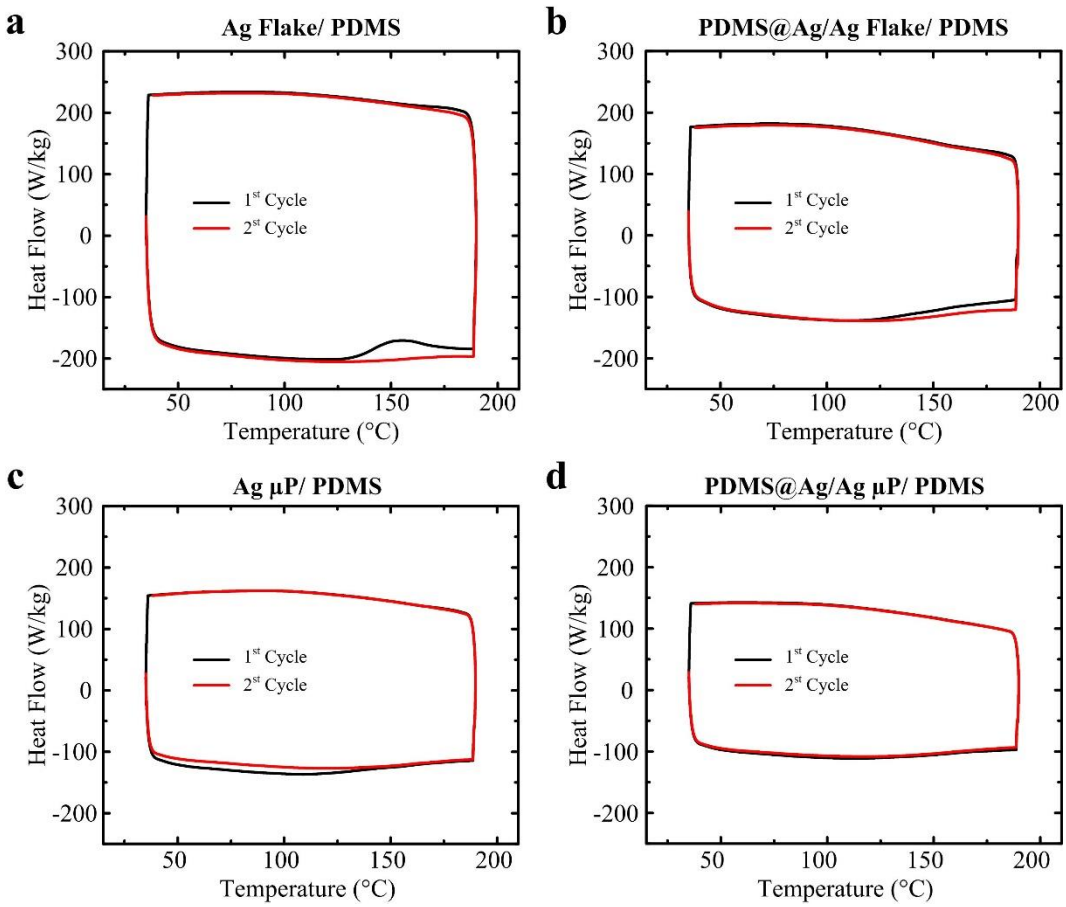

Figure S5 Differential scanning calorimetry (DSC) measurements: (a) Ag flake/PDMS, (b) PDMS@Ag/Ag flake/PDMS PS3 composite, (c) Ag microparticle/PDMS, and (d) PDMS@Ag/Ag microparticle/PDMS PS3 composite.

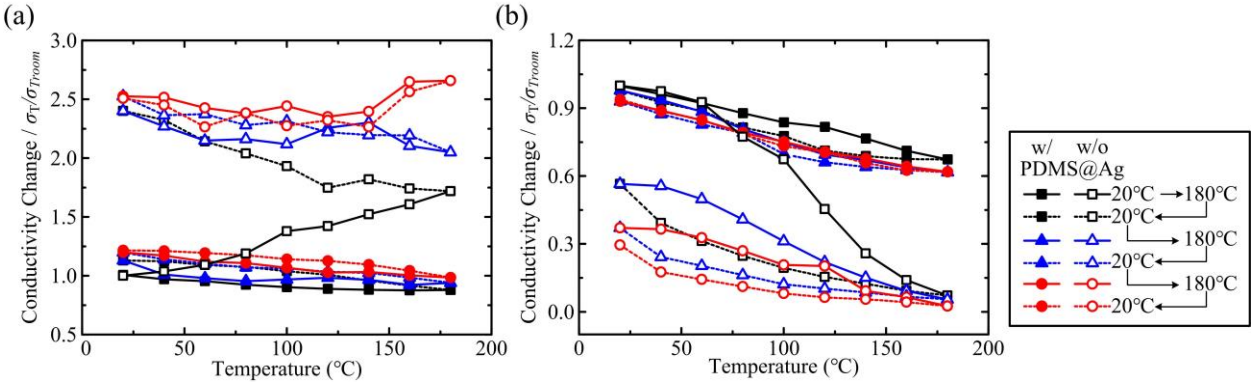

Figure S6. Electrical conductivity change of elastic conductors for composites with/ without PDMS@Ag as a function of cyclic temperature loading for multiple temperature cycles for: (a) Ag flakes, and (b) Ag microparticles.

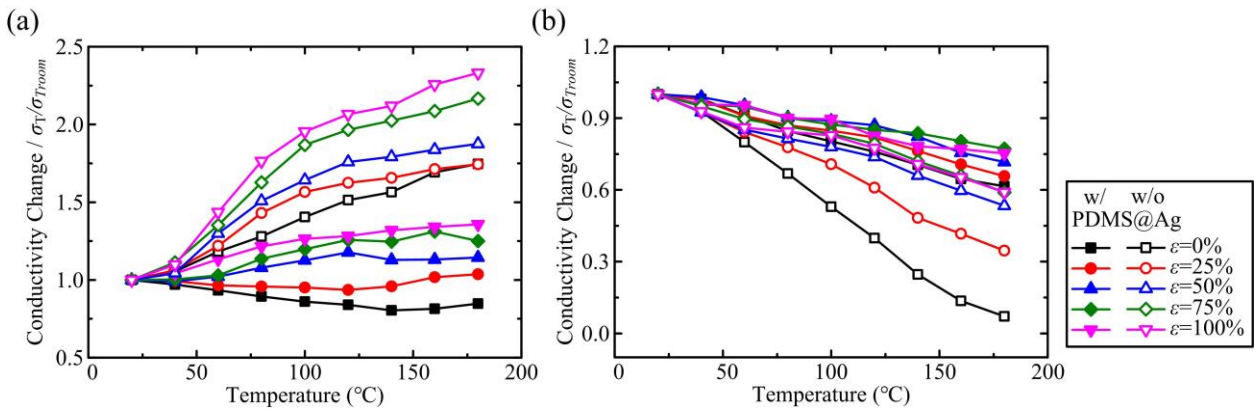

Figure S7. Electrical conductivity change of elastic conductors for composites with/ without PDMS@Ag as a function of temperature at different strains: (a) Ag flakes, and (b) Ag microparticles.

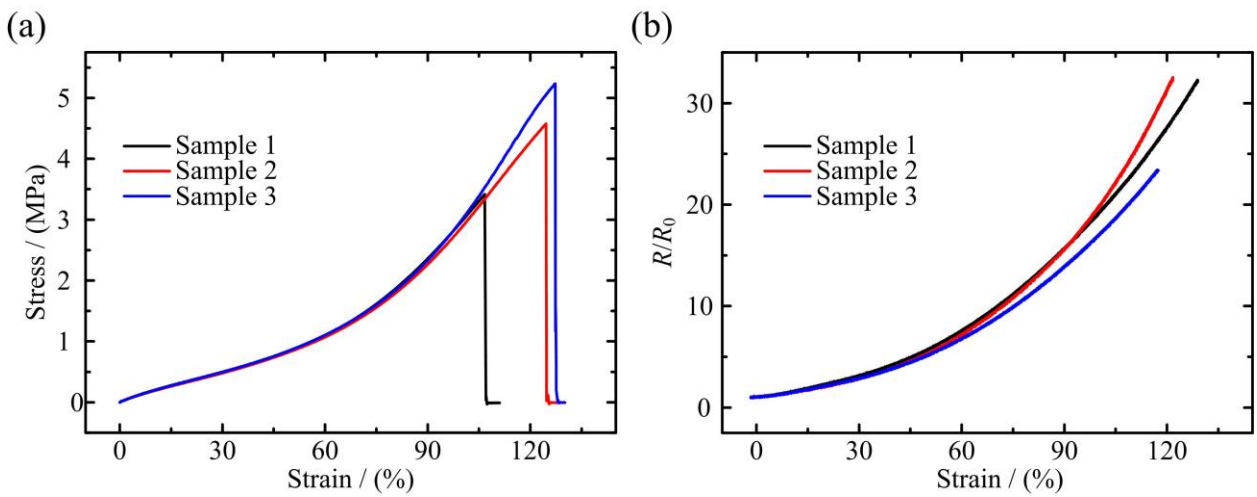

Figure S8. (a) Stress-strain curves of PS3 composites with Ag flakes, and (b) Resistance change as a function of strain until to mechanical failure.

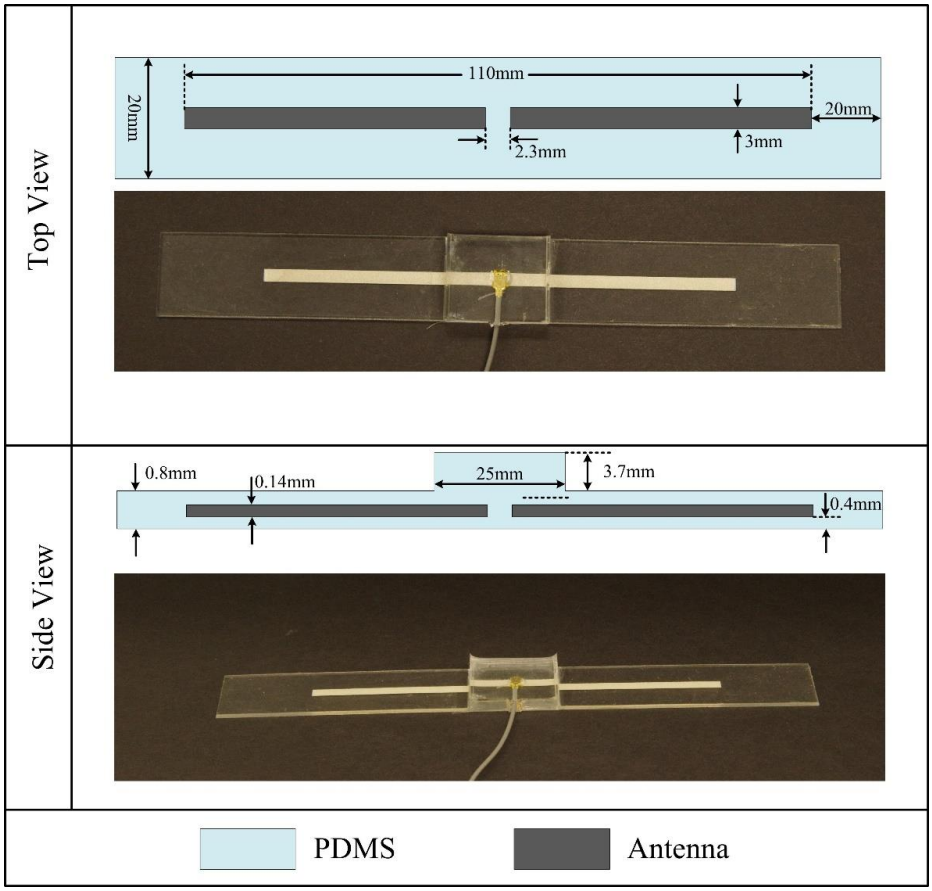

Figure S9 Design schematic and photograph of stretchable antenna for vector network analyzing.

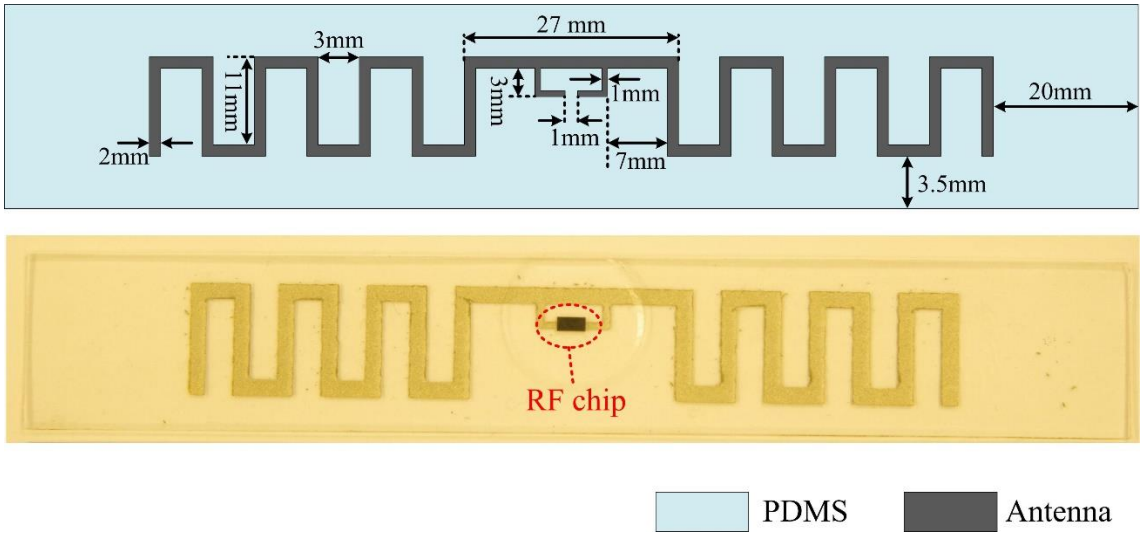

Figure S10 Design schematic and photograph of RFID tag for smart glove.

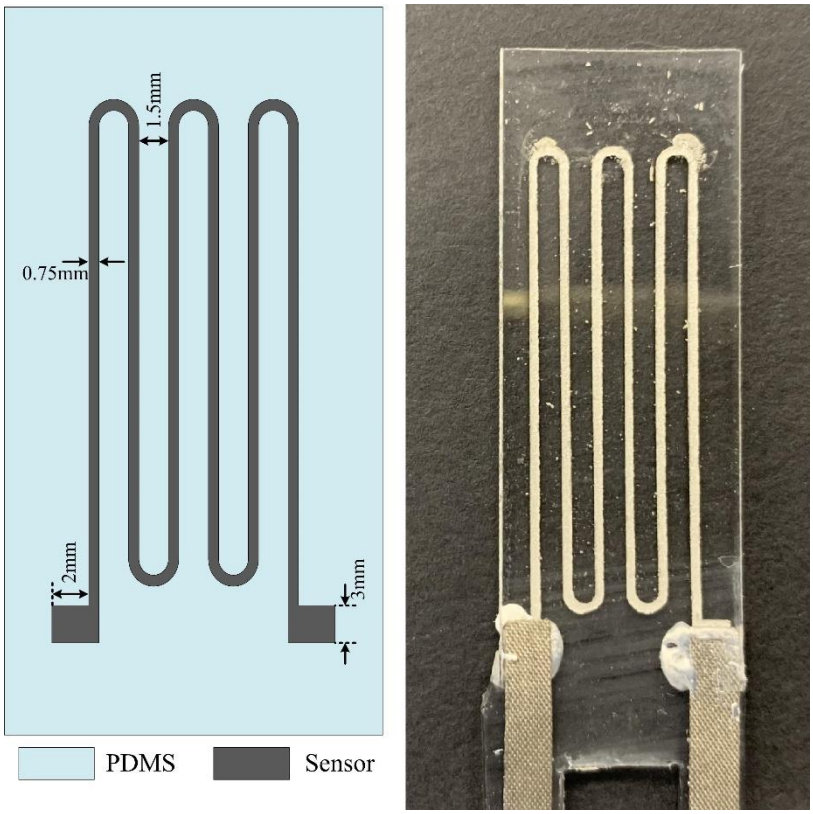

Figure S11 Design schematic and photograph of strain sensor.

S3 Supporting Videos

Supporting Video-1: Stretchable antenna for "smart" furnace glove. This video shows the hand gestures monitoring in a high temperature environment (100 ℃ furnace). The fingers are cycled through different hand gestures, where the signal strength of each individual RFID tag is plotted on the monitor. The activated fingers are highlighted at the top-right corner.

Supporting Video-2: Strain sensor for soft gripper using in hot water. This video presents the grasping of a food object (red potato) in a bath of hot water (60 ℃).