Electronic Upcycling of Corn Straw: Biobased Elastic Conductive Cross-linked Network Eco-friendly Hydrogels with multifunction for Flexible Wearable Sensors

Supporting information

S1. Self-adhesive properties of CSP-MCG

As CSP-MCG is rich in hydroxyl and carboxyl groups, it shows good adhesive properties and can be bonded to the surface of different materials more easily. These include: glass sheets, plastic sheets, copper sheets, wood blocks, carbon fiber boards, aluminum sheets, rubber mold, foams, finger surfaces. As shown in the figure, when the gel adheres to the surface of a material, it provides a surface adhesion force sufficient to lift it against gravity.

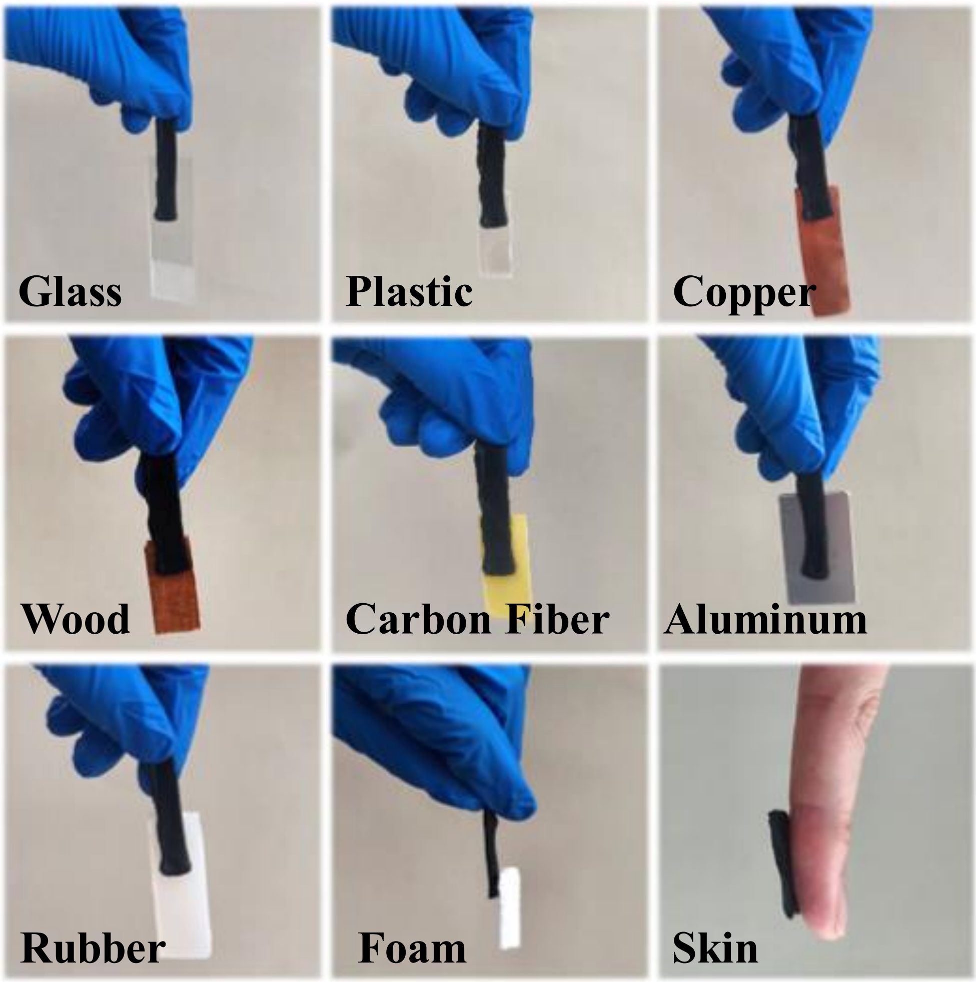

Figure S1. Schematic picture of CSP-MCG adhesion to different substrates.

S2. Shear stress resulting from interfacial stripping off CSP-MCG adhering to different substrates

The self-adhesive property of hydrogels is a characteristic that is beneficial as a wearable sensing gel. The magnitude of surface peeling shear stresses for adherence to different materials is shown in the radial histogram below. As can be seen from the results in the figure, CSP-MCG is not only biocompatible but also has good adhesion when it is adhered to the human surface.

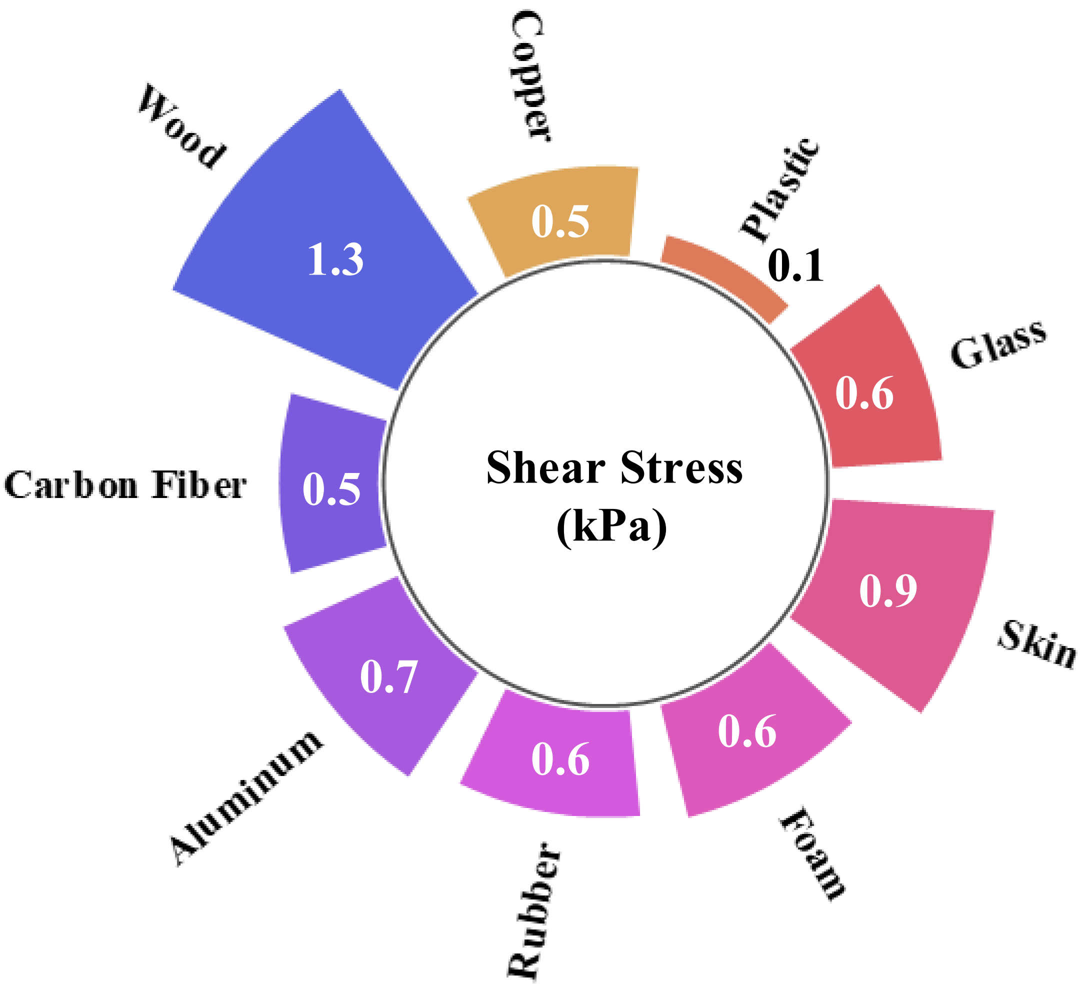

Figure S2. Surface peeling shear stress of CSP-MCG adhering to different substrates

S3. The test results of CSP-MCG as piezoresistive material

CSP-MCG not only exhibits elasticity in tension, but also maintains good elasticity when subjected to external pressure to produce deformation. From the stress-strain curves shown in FIG. S3(a), it can be observed that the curves in the compression stage basically overlap under different magnitudes of force, and the curves in the rebound stage all return to the starting point. These experimental results indicate that CSP-MCG has stable rebound properties. Therefore, when subjected to 40% continuous compressive stress (as shown in FIG. S3(b)) , it is able to output the electrical signal stably. This reaffirms the reliable combination of elastic and conductive materials in the CSP-MCG system, which gives it the ability to change the resistance value with shape change. In addition, as a piezoresistive material, when subjected to a large external load (20 Kpa) and held for 10 s, the electrical signals remain basically unchanged as can be seen in FIG. S3(c), which exhibits good stability. It is worth noting that the response time of the CSP-MCG is less than 0.2 s at the moment of pressure, which possesses a fast response speed. FIG. S3(d) shows the functional relationship of the resistance change rate of CSP-MCG as a piezoresistive material as a function of the change in pressure magnitude, and the corresponding linear fitting curve is given. From the figure, it can be observed that the best linearity (R2=0.99) is presented when the external pressure is high in the range of zone I. The best linearity (R2=0.99) is observed when the external pressure is high in the range of zone II. When in the zone II, the linearity decreases slightly (R2=0.96), probably due to the change in sensitivity. When the external pressure increases from the zone I to zone II, the sensitivity decreases from GF=5.9 to GF=1.1.

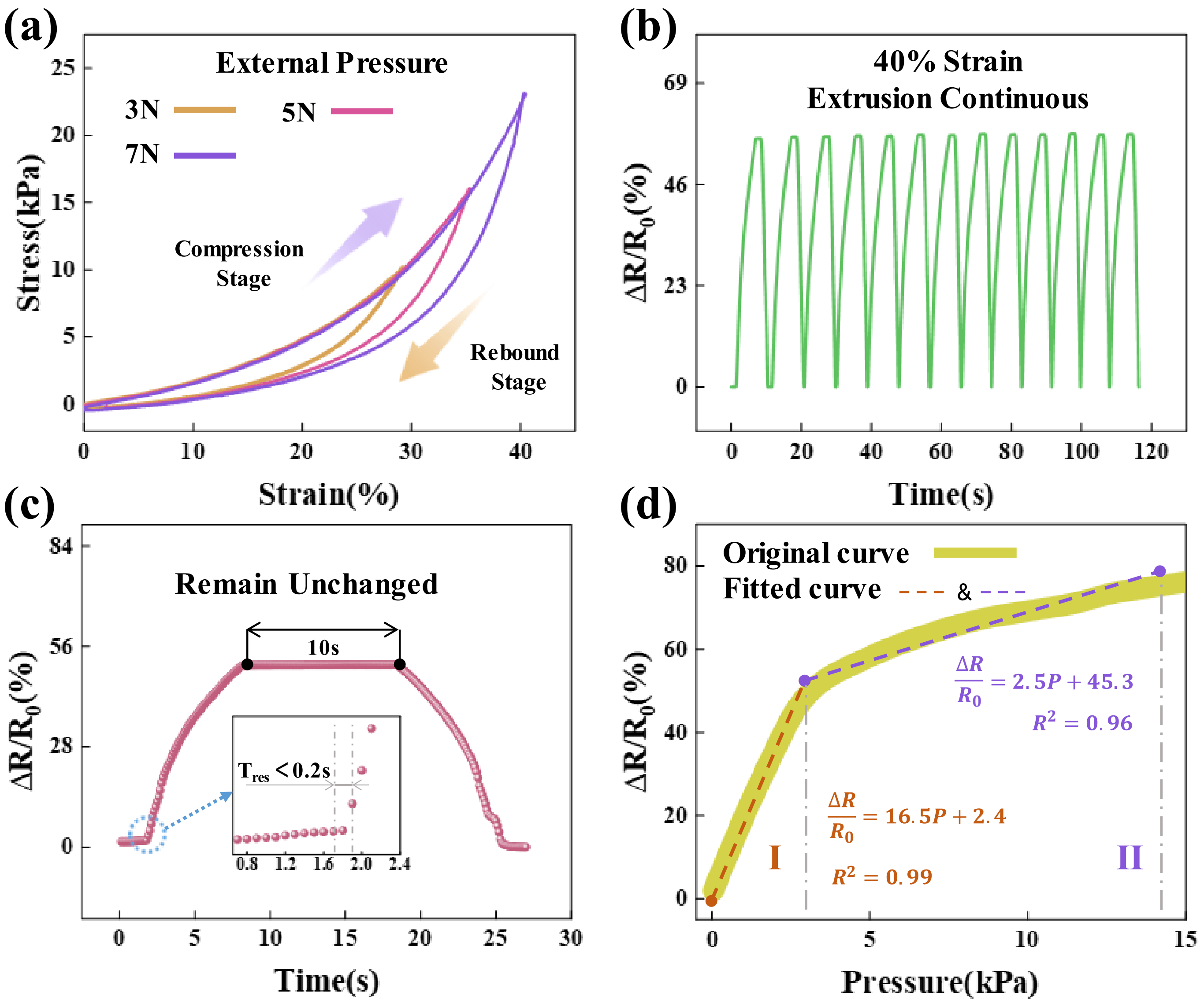

Figure S3. Piezoresistive characteristics of CSP-MCG. (a) Hysteretic curve of stress-strain under CSP-MCG compression; (b) Continuous extrusion of CSP-MCG produces an electrical signal change under 40% strain; (c) CSP-MCG as a piezoresistive material, its response time and maintaining stability diagram; (d) Linear fitting curve of resistance changes of CSP-MCG under pressure.