A Tough, Stretchable, Durable, Ultrathin, Self-limiting and Skin-like Substrate with Sensing Capability

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The sensory receptor system which is distributed throughout the skin imparts sensory ability in human skin. Stiff networked collagen nanofibers beneath the epidermis make human skin stretchable at low strain and self-limiting at large strain to protect it against large deformation. To mimic sensory and mechanical ability of human skin a tough, stretchable, ultrathin, transparent, self-limiting and functional substrate is fabricated by embedding high modulus poly (vinylidene fluoride-co-trifluoroethylene) (P(VDF-TrFE)) nanofibers into low modulus elastomer polydimethyl-siloxane (PDMS). Most commercial elastomeric materials have low elastic modulus and therefore are not tough enough to be handled easily during fabrication processes. The large stretchability of these elastomers is not capable of protecting devices from high stretching. The random distribution of nanofibers into elastomer matrix act as reinforcing filler which provide high durability to stretch at low strains but prevents rupture when subjected to high stretching. The stretchability, toughness,Young\'s modulus and piezoelectricity of ultrathin (~62 um) skin-like substrate with high optical transparency is tuned by controlling the loading of stiff and functional P(VDF-TrFE) nanofibers. To measure sensing functionality of skin-like substrate poly(3,4ethylenedioxythiophene): poly(styrenesulfonate) (PEDOT: PSS)/ionic liquid (1-ethyl-3-methylimidazoliumtetracyanoborate) electrodes on both sides of a skin-like substrate is coated.With an increase in applied impact pressure from 0.25 to 1.1 kgf, V_{OC} increases gradually from 0.07 to 0.19 V at a forcing frequency of 0.2 Hz with 0.2mL P(VDF-TrFE) electrospun volume. Piezoelectricity of P(VDF-TrFE) nanofibers detects dynamic pressure and strain.A stretchable temperature sensor is fabricated on the skin-like substrate to generate a novel stretchable electronic device capable of mimicking both the sensory ability and mechanical behavior of human skin while being resistant to the effects of mechanical deformation on the electrical signal change of the sensor device on it. This skin-like substrate accommodates body movements and is efficient to maintain its sensing abilities.