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A Mechanically Robust and Versatile Liquid-Free Ionic Conductive Elastomer

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Soft ionic conductors, such as hydrogels and ionogels, have enabled stretchable and transparent ionotronics, but they suffer from key limitations inherent to the liquid components, which may leak and evaporate. Here, novel liquid-free ionic conductive elastomers (ICE) that are copolymer networks hosting lithium cations and associated anions via lithium bonds and hydrogen bonds are demonstrated, such that they are intrinsically immune from leakage and evaporation. The ICEs show extraordinary mechanical versatility including excellent stretchability, high strength and toughness, self-healing, quick self-recovery, and 3D-printability. More intriguingly, the ICEs can defeat the conflict of strength versus toughness—a compromise well recognized in mechanics and material science—and simultaneously overcome the conflict between ionic conductivity and mechanical properties, which is common for ionogels. Several liquid-free ionotronics based on the ICE are further developed, including resistive force sensors, multifunctional ionic skins, and triboelectric nanogenerators (TENGs), which are not subject to limitations of previous gel-based devices, such as leakage, evaporation, and weak hydrogel–elastomer interfaces. Also, the 3D printability of the ICEs is demonstrated by printing a series of structures with fine features. The findings offer promise for a variety of ionotronics requiring environmental stability and durability.