Abstract Submitted
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**Weak hydrogen bonding yields rigid, tough, and elastic hydrogels**[1] SERGEI SHEIKO, XIAOBO HU, MOHAMMAD VATANKHAH-VARNOSFADERANI, JING ZHOU, QIAOXI LI, University of North Carolina at Chapel Hill, ANDREY DOBRYNIN, University of Akron — Unlike living tissues, synthetic hydrogels are inherently soft and brittle, particularly when built of hydrogen bonds. It remains challenging to design hydrogels that combine high rigidity, strength at break, extensibility, high elasticity. Through free-radical copolymerization of $N,N$-dimethylacrylamide and methacrylic acid, we have designed a network system based on tunable composition of covalent bonds (permanent cross-links) and hydrogen bonds (sacrificial and recoverable crosslinks) with the following rationale: 1) Maintain a high total number of cross-links to ensure high modulus; 2) Introduce a high fraction of H-bonding to ensure high energy dissipation; and 3) Incorporate a small fraction of permanent cross-links to ensure shape control. By tuning the chemical composition and microstructure we have obtained materials with superb mechanical properties. The hydrogels contain 70 wt% water (similar to living cartilage, skin, and ligaments), while display modulus of 28 MPa, strength of 2 MPa, fracture energy of 9300 $\mathrm{J{\cdot}m^{-2}}$, extensibility of 800%, excellent fatigue-resistance, and great elasticity allowing for complete and fast strain recovery. The results agreed with theoretical predictions for modulus relaxation of dual networks with dynamic and permanent crosslinks.

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