A highly efficient self-healing elastomer with unprecedented mechanical properties

With the support by the National Natural Science Foundation of China, the research team led by Prof. You ZhengWei (游正伟) at the State Key Laboratory for Modification of Chemical Fibers and Polymer Materials, College of Material Science & Engineering, International Joint Laboratory for Advanced Fiber and Low-dimension Materials, Donghua University, recently reported a highly efficient self-healing elastomer with unprecedented mechanical properties, which was published in *Advanced Materials* (2019, 1901402).

Self-healing is one of the most attractive properties for next generation materials and shows great promise in many fields such as automotive coatings, soft robotics, and wearable electronics. Ideally, the healable materials should spontaneously repair at room temperature while exhibiting high initial and recovered mechanical strength and toughness. However, incorporating both of these properties into a material has presented a great challenge since they are often achieved by contradictory approaches.

To address this challenge, You's group presents a novel Cu(II)-dimethylglyoxime-urethane coordination complex based polyurethane elastomer (Cu-DOU-CPU) with synergetic triple dynamic bonds. Cu-DOU-CPU demonstrates the highest reported mechanical performance for self-healing elastomers at room temperature, with a tensile strength and toughness up to 14.8 MPa and 87.0 MJ m^{-3}, respectively. Meanwhile, Cu-DOU-CPU spontaneously self-heals at room temperature with an instant recovered tensile strength of 1.84 MPa and a continuously increased strength up to 13.8 MPa, surpassing the original strength of all other counterparts. The key of this strategy is Cu(II)-DOU coordination complex, which greatly strengthens the materials while enhancing the dynamics of DOU bonds to facilitate self-healing. Prof. Bao XiaoGuang's group at Soochow University performs density functional theory calculations to demonstrate the molecular mechanism.

This material design provides a powerful new strategy to reconcile the contradictory properties of mechanical robustness and self-healing efficiency that can also be expanded to other metal ions and dynamic bonds. In addition, the synthesis of Cu-DOU-CPU elastomer is a simple one step process using commercially available reagents that can be readily scaled up. This research will inspire a series of strong self-healing materials with diverse applications.

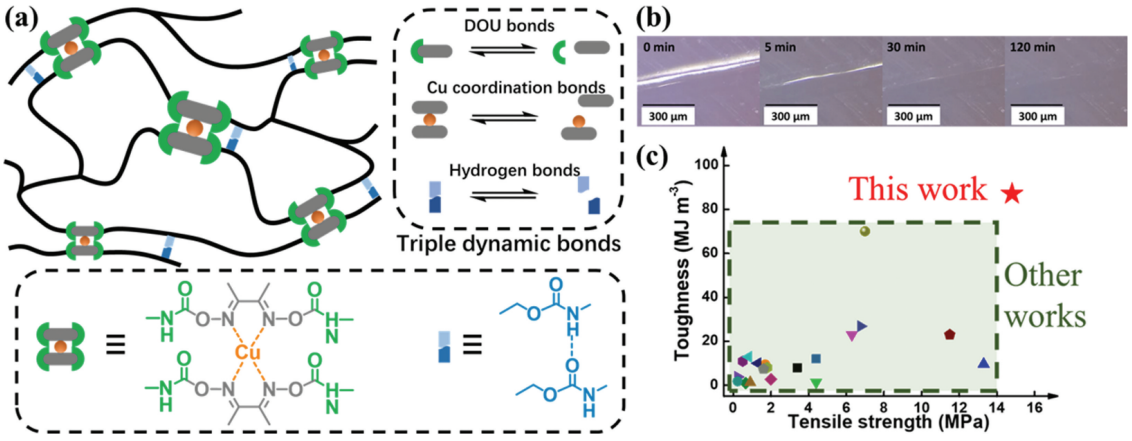

Figure (a) Design of Cu—DOU—CPU elastomer. (b) Optical microscopy images of Cu—DOU—CPU film after being scratched. (c) Ashby plot of "toughness" and "tensile strength" of Cu—DOU—CPU and other room temperature self-healing elastomers reported in literature.