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Simple modeling of biological composites, kirigami, and viscoelastic crack propagation

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In this talk, we use simple models to provide a clear understanding of mechanical properties of different materials. We discuss biological composites, kirigami (sheet of paper with many cuts), and crack propagation in viscoelastic materials.

In certain biological composites such as nacre and spider webs, the combination of soft and hard elements seems indispensable for achieving high strength and toughness. In this talk, we discuss the mechanical superiority of such soft-hard biological composites. As a result, we provide an intuitive understanding of how their remarkable structures contribute to enhancing their fracture resistance in the presence of cracks, and how such structures are physically optimized in terms of mechanical properties [1-3].

Kirigami is a highly stretchable sheet material and has been received much attention especially because of its potential for various engineering applications such as graphene kirigami and stretchable batteries. In this talk, we show that the high stretchability emerges from a transition from in-plane to out-of-plane deformation, providing scaling laws that describe experiment well [4].

It is known that the velocity of crack propagation in elastomers exhibits a significant jump as the applied load is increased, which could trigger catastrophic failure in automobile tires. Physical understanding of this velocity jump is important from fundamental and industrial points of view. In this talk, we present an exactly solvable model for the phenomena to provide a clear physical understanding of the velocity jump [5].

References

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