Bioinspired Molecular Composites of 2D-Layered Materials and Tandem Repeat Protein

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Composite materials are the combination of two or more materials with varying characteristics to achieve higher performance in a specialized application. Due to their benefits, there are many examples of composites in the industry, however nature was making use of composites long before we started benefiting from them. Nature is limited in material selection, therefore the structural hierarchy of materials in nature is essential to achieve desirable mechanical strength and toughness. This hierarchy is established via evolution over billions of years to tune and optimize.

Similarly, two-dimensional (2D) layered composites show extraordinary mechanical, electronic, optical, and thermal properties. However, the brittle nature of 2D nanosheets drastically restricts manufacturing of flexible and stretchable composites. In our previous work, we demonstrated up to 58.5% stretchability while maintaining high toughness and tensile strength. Additionally, we discovered the importance of interfacial interactions between the filler and the matrix in layered composites. For further investigation, we are using molecular dynamics (MD) simulations to match our experimental results using LAMMPS software. The results of our simulations will reveal the connection between the bulk properties we measured in the lab to the molecular interactions we simulate in the simulations.