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Hierarchically roughened microplatelets enhance the strength and ductility of nacre-inspired composites

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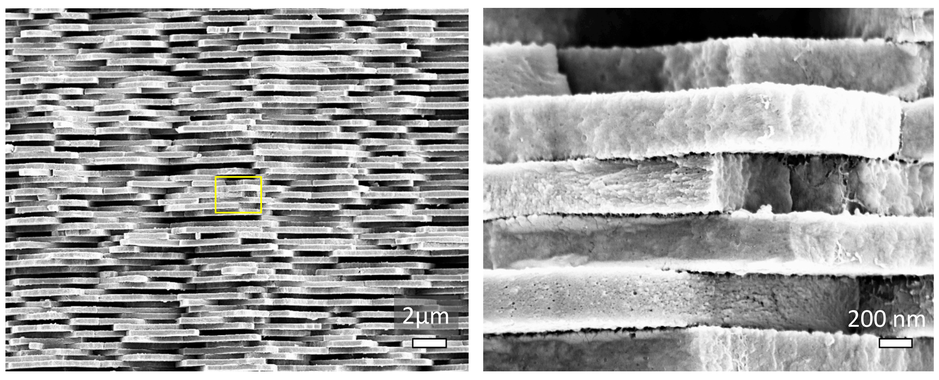
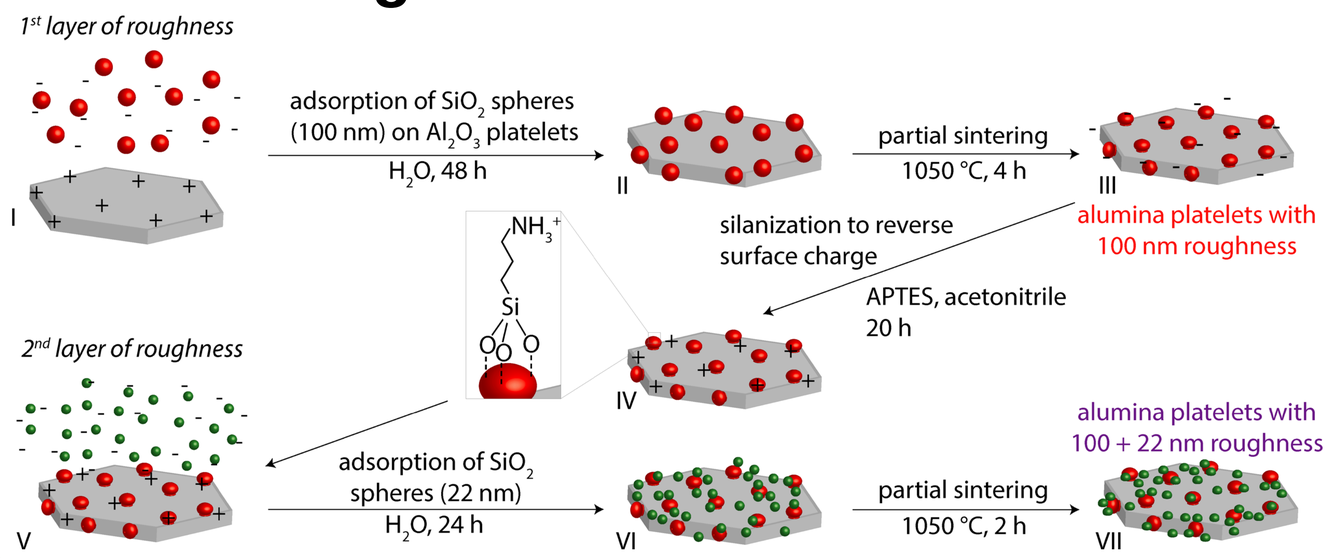
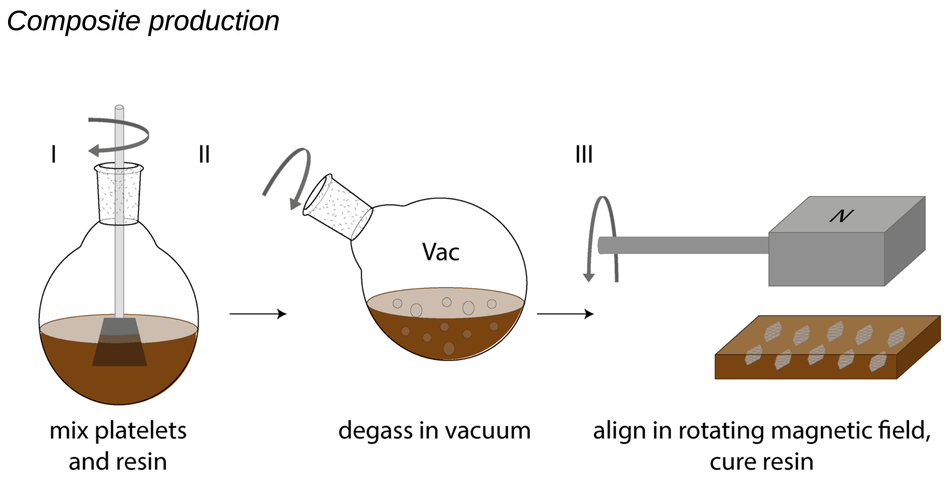
Motivation

Rough interfaces play a major role in the mechanics of nacre, the brick-and-mortar type inner layer of some mollusk shells. Nanoscale asperities on the "brick" surface enable toughening mechanisms such as platelet–platelet and platelet–matrix interlocking. To gain further insights into the effect of asperity size, hierarchy and coverage on the mechanics of artificial nacre-inspired composites, we decorate alumina microplatelets with silica nanoparticles of selected sizes and use the resulting roughened platelets as reinforcing elements in a commercial epoxy matrix.

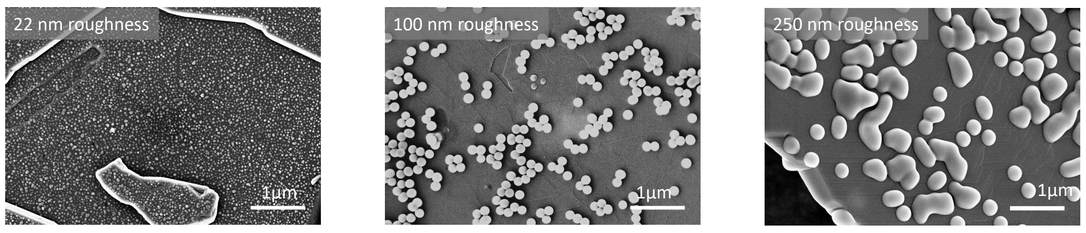


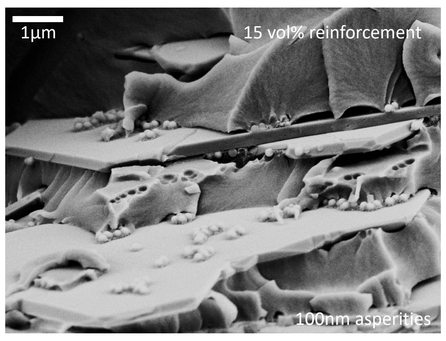
Processing

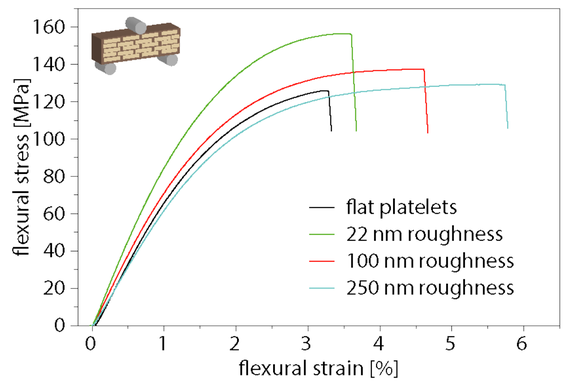


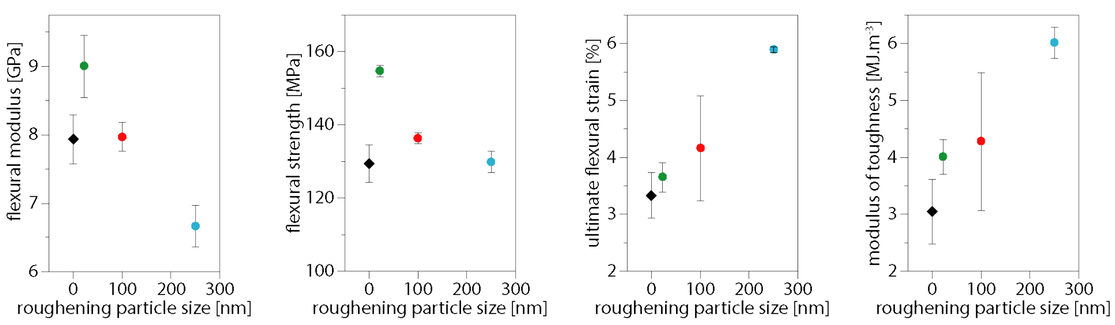


Single-level roughened

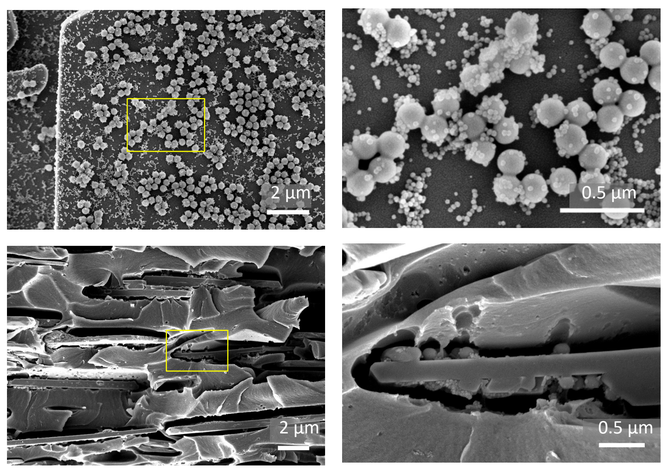


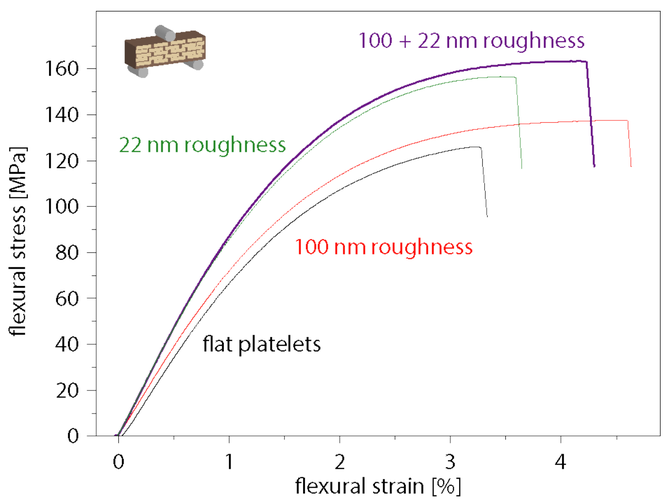


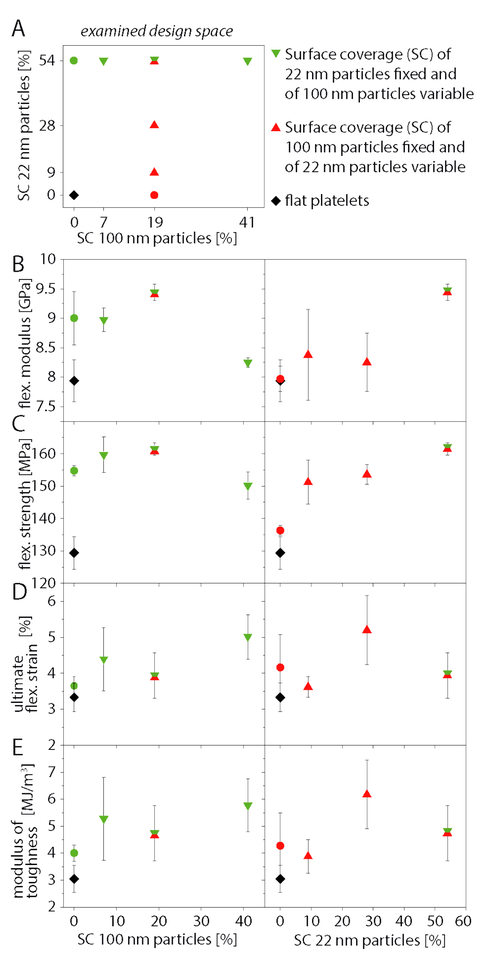




Hierarchically roughened







Conclusion

For a single layer of silica nanoparticles on the platelet surface, increased ultimate strain and toughness are obtained with a large roughening particle size of 250 nm. On the contrary, strength and stiffness are enhanced by decreasing the size of asperities using 22 nm silica particles. By combining particles of two different sizes (100 nm and 22 nm) in a hierarchical fashion, we are able to improve stiffness and strength of platelet–reinforced polymers while maintaining high ultimate strain and toughness. Our results show that carefully designing hierarchically roughened interfaces can enhance the mechanical performance of nacre-inspired composites.

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