ABSTRACT

Understanding Structure-Property Relationships in Dental Enamel

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Acellular hard tissues found in the outer layers of various species's teeth cannot re-grow or heal whe n damaged. Despite this, these tissues endure sometimes millions of loading cycles in abrasive envir onments, even though they are composed of brittle minerals.

The dental enamal of different species exhibits a variety of adapations optimised not only for fracture toughness, but also hardness or abrasion behaviour. These adaptations are achieved due to sophisti cated, hierarchical microstructures of three-dimensionally interwoven mineral fibre bundles [1,2,3]. Understanding how these tissues achieve such durability can provide insights into the design of stron g, fracture-resistant materials..

Using finite element simulations and nanoindentation experiments, it is demonstrated that variation s in microstructure, feature orientation, and feature size affect the effective mechanical properties of the enamel of the red-necked wallaby (Macropus rufogriseus), in comparison with various other spec ies. We find a shallow gradient in stiffness and low degree of anisotropy over the enamel thickness th at is attributed to the orientation and size of microstructural features [4]. Most notably, M. rufogriseu s' modified radial enamel has a far simpler structural pattern than other species', but achieves great property amplification.

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