

Abstract Submitted
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A Fracture Resisting Molecular Interaction in Trabecular Bone: Sacrificial Bonds and Hidden Length Dissipate Energy as Mineralized Fibrils Separate¹ GEORG E. FANTNER, UCSB, TUE HASSENKAM, JOHANNES H. KINDT, JAMES C. WEAVER, HENRIK BIRKEDAL, LEONID PECHENIK, JACQUELINE A. CUTRONI, LAURA S. GOLDE, MARQUESA M. FINCH, PHILIPP THURNER, GERALDO A.G. CIDADE, GALEN D. STUCKY, DANIE E. MORSE, PAUL K. HANSMA — A molecular energy dissipation mechanism in the form of sacrificial bonds and hidden length was previously found in bone constituent molecules of which the efficiency increased with the presence of Ca^{2+} ions in the experimental solution. Here we present evidence for how this sacrificial bond-hidden length mechanism contributes to the mechanical properties of the bone composite. From investigations into the nanoscale arrangement of the bone constituents in combination with pico-Newton adhesion force measurements between mineralized collagen fibrils, based on single molecule force spectroscopy, we find evidence that bone consists of mineralized collagen fibrils and a non fibrillar organic matrix which acts as a “glue” that holds the mineralized fibrils together. We propose that this “glue” resists the separation of mineralized collagen fibrils. Like in the case of the sacrificial bonds in single molecules, the effectiveness of this “glue” increases with the presence of Ca^{2+} ions. We further investigate how this molecular scale strengthening mechanism increases the fracture toughness of the macroscopic material.

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