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Research paper

Measuring the dynamic mechanical response of hydrated mouse bone by nanoindentation

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ARTICLE INFO

Article history:
Received 20 May 2010
Received in revised form
30 August 2010
Accepted 5 September 2010
Published online 16 September 2010

Keywords:
Bone
Viscoelasticity
Nanoindentation

ABSTRACT

This study demonstrates a novel approach to characterizing hydrated bone's viscoelastic behavior at lamellar length scales using dynamic indentation techniques. We studied the submicron-level viscoelastic response of bone tissue from two different inbred mouse strains, A/J and B6, with known differences in whole bone and tissue-level mechanical properties. Our results show that bone having a higher collagen content or a lower mineral-to-matrix ratio demonstrates a trend towards a larger viscoelastic response. When normalized for anatomical location relative to biological growth patterns in the antero-medial (AM) cortex, bone tissue from B6 femora, known to have a lower mineral-to-matrix ratio, is shown to exhibit a significantly higher viscoelastic response compared to A/J tissue. Newer bone regions with a higher collagen content (closer to the endosteal edge of the AM cortex) showed a trend towards a larger viscoelastic response. Our study demonstrates the feasibility of this technique for analyzing local composition–property relationships in bone. Further, this technique of viscoelastic nanoindentation mapping of the bone surface at these submicron length scales is shown to be highly advantageous in studying subsurface features, such as porosity, of wet hydrated biological specimens, which are difficult to identify using other methods.

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doi:10.1016/j.jmbbm.2010.09.002