The indentation technique has become a standard method to extract the mechanical properties of various materials. In recent years, mechanical behaviors of bone at the level of osteons or even lamellae have been assessed via nanoindentation of bone. Different procedures during the indentation test can be used for different testing purposes. A conventional test provides the hardness of materials by measuring the size of the residual indentation impression. The load and indentation depth can also be recorded to form an indentation curve, which reveals information regarding mechanical properties.

There are many material models for bone, reflecting its anisotropic structure. On large scales and small strain levels, bone can be modeled as viscoelastic or viscoelastic-plastic. On micron scales, cortical bone consists of osteons surrounded by interstitial bone, while trabecular bone consists of structures similar to rods or plates. Continuum models on the micron scale represent the overall behavior during indentation, regardless of the different structures and the interactions between structures. However, on the nano scale,
indentation becomes more localized, and the hierarchical structure of bone as well as the behaviors of collagen and mineral phases needs to be taken into consideration.

The objective of this research is to advance the state of knowledge in simulation of the nanoindentation behavior of bone. The goal is to provide greater insight into bone mechanics on a nano-scale, which has a clinical significance. The ability to localize testing to very small regions is also important given that drug therapies often localize their effects to distinct tissue regions at micro- and/or nano-scales. Thus, determination of localized effects of drug therapies, in so far as they affect mechanical properties, is another benefit of nanomechanical testing and modeling. To achieve this, various material models are developed and applied in simulations using the finite element methods, and in some cases, analytical analysis.