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Cloud computing in nanoHUB powering education and research

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ABSTRACT

Atomic force microscopy (AFM) is a powerful tool for imaging and quantitatively mapping the mechanical properties of materials at the micro- and nanoscales. In AFM, a microcantilever with a sharp tip interacts with the sample over various time scales and the interaction force history over this short interval of time contains rich information from which the local physical properties of the sample can be extracted. However, these tip–sample interactions cannot be directly controlled or measured. Thus, no experimental observable is directly proportional to the tip–sample interactions while scanning a sample. Moreover, these nonlinear interaction forces between the tip and sample, microcantilever dynamics, tip sample geometry convolution, and the feedback control system cumulatively affect the resulting AFM images and thus the material property maps. Therefore, a better understanding of suitable operating conditions for a specific experiment is important for an experimentalist since the underlying nonlinear dynamics in AFM is complex and nonintuitive. Comprehensive simulations can provide an insight into what operating conditions to choose for a specific experiment. Here, we present the key capabilities of web-based simulation tools for AFM, Virtual Environment for Dynamic Atomic force microscopy (VEDA) which was first introduced by Melcher et al. [1] in 2008. The tool has been developed since then, and now it consists of different modules to simulate AFM experiments in both ambient and liquid environments [2] with 19 different tip–sample interaction models. This is a web–based tool that is freely available on nanoHUB [3] for AFM users and is the most widely used AFM simulation tool in the world with about 1700 users worldwide. AFM users can develop a deeper quantitative understanding of AFM with the aid of simulation tools like VEDA.