Dynamic mode atomic force microscopy toward characterizing material properties at nano-scale

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Quantitative estimation of material properties covers important spectrum of applications of atomic force microscopy (AFM). Among the diverse operational modes of AFM [1], the dynamic mode of operation [2] is particularly suitable for imaging soft materials. This work discusses some important techniques to estimate the surface mechanical properties of materials utilizing the dynamic mode AFM. The viewpoint of equivalent cantilevers is a key enabler for such approach which is also implicitly assumed in many studies reported in literature. Two different equivalent cantilever based approaches, namely, the steady state estimation of equivalent parameters (SEEP) and the recursive estimation of equivalent parameters (REEP) methods are discussed which enable researchers to characterize the local surface mechanical properties of materials [3]. Performance comparison and trade-offs among the SEEP and REEP methods are presented. The REEP technique is a higher bandwidth estimation method compared to SEEP. However, the REEP method is computationally more complex compared to SEEP and requires significant effort to be implemented on real-time hardware. Thus, an overview of the design steps and architecture of a REEP module implemented on Field Programmable Gate Arrays (FPGA) is outlined. The step by step approach developed in this work can be used as recipe by AFM researchers to investigate materials of their interest with minimal customization of commercially available dynamic mode AFM setups.

References

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