Mechanical education for nanoscience and nanotechnology in future

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Traditional mechanical education is mainly based on the continuum mechanics and Neuton's equation. As the dimension of materials and devices has shrunk deeply into nanoscale, the atomic arrangement becomes crucial in correlating the functions. Molecular mechanics theory then is used to combine with the continuum model to reveal the essential physics of the nanoscale, but still being unable to capture the electronic effect. Especially, the peculiar electronic behaviors originating from the surface and size confinement will dominate the properties and functions of nanomaterials. What is more, the local fields of the atom structures, such as the electronic structure, molecular orbitals, charge density and spin states, become strongly coupled with the applied mechanical forces or strain, external electric field, magnetic field or optical action to the nanomaterials. These coupling effects entail even very common matters, such as carbon and BN materials, many intelligent characters. These behaviors from the multi-field coupling provide the essential basis of developing new principle nanodevices. To more reliably consider these effects and precisely probe the behavior of the nanomaterials at nano/molecular scale, we have to unify the continuum principles and molecular mechanics with the state-of-the-art quantum mechanics theory.

Therefore the mechanical education also needs to be keep up timely with these changes. Especially, mechanical education should go beyond the traditional mode and needs to enhance the understandings in interdisciplinary fields. Especially, we need to guide the students to understand the new advances of researches and extract the research idea by themselves from some realms that have attracted the most attention. Meanwhile, in the mechanical researches, mastering research methods belonging to different subjects is also important. For example, in the study of mechanical behaviors of materials, especially the nanometerials, using first-principles method has become an important way to gain insight into the atomistic mechanism governing the material deformation. In this paper, I will combine the experience in advising students to perform physical mechanics studies on materials of carbon and BN systems, and present some of my insights on the mechanical educations in the new age.

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