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Molecular Dynamics Simulation Study of Vibration-assisted Nanocutting Process

Nanomachining techniques provide unique and novel opportunities to fabricate three-dimensional nanostructures and components with nanometric surface finish and ultraprecision. Nanocutting is one such technique which uses a single point cutting tool to perform nanometric machining. Nanocutting has been extensively used to machine wide range of materials including polymers, metals, thin films and electronic materials. Nanocutting processes suffers from several limitations including high tool wear rate, tool breakage, and surface damage and so on. Addition of vibration to the tool used in nanocutting process has shown to improve the tool life as well as machining accuracy. However, the material removal mechanisms and tool wear mechanisms involved in vibration-assisted nanocutting process is still unclear. As nanocutting involves changes in only a few atomic layers at the surface region, it is extremely difficult to observe the machining process and to measure the process parameters through experiments. Molecular dynamics (MD) simulation has been demonstrated to be a powerful tool to explore the material removal mechanisms involved in nanoscale processes. This research studies the material removal mechanisms and tool wear mechanisms involved in vibration-assisted nanocutting process using MD simulation technique. The effects of the cutting depth, cutting speed, crystal orientation and cutting direction on materials deformation, dislocation movement and cutting forces during the vibration-assisted cutting processes will be studied.