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Author Sung-Lin Tsai
Author's Email Address No Public.
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Abstract
In the study the scanning probe microscopy (SPM) and molecular dynamics (MD) simulations are employed to investigate three-dimensional nanomachining and nanoindentation. This study includes both theoretical and experimental parts：In the theoretical part, the load effect, the speed effect, the hold time and temperatures were used to simulate characteristics of the nanomachining and nanoindentation. The MD was carried out to understand the material remove rate, the cutting depth, the elastic-plastic energy, the contact stress-strain, the adhesive contact formation, the Young's modulus and hardness of materials. In the experimental part, the mechanical properties of metals and semiconductors materials are studied using SPM-based nanomachining and nanoindentation. The materials remove rate, surface roughness, cutting depth at different loads and cutting feeds were discussed. The Young's modulus, the hardness, the plastic energy, the elastic recovery and the contact stress-strain under different indentation load, loading rates, hold times and the fatigue behavior were also measured. The scanning electron microscopy (SEM), scanning near-field optical microscopy (SNOM) and optical microscopy (OM) were employed to measure the microstructure properties. The experimental result was compared with those of molecular dynamics simulations. The results showed that the materials remove rate and surface roughness increased as the load and the cutting feed were increased. The Young's modulus and hardness of the metals, and the semiconductors were increased as the indentation load, hold time effect and the fatigue effect were changed. In the elastic recovery(△e), the metals is 18％-20％(Au)、20％-24％(Pt), but the semiconductors is 76％-80％(Si)、46％-60％(GaAs)；In the yield strength ,the metas is σr1(Pt)=28GPa，σr2(Au)=23GPa, but the semiconductors（Si、GaAs），σγ1（Si）=29 GPa，σγ2（GaAs）=23 GPa。Furthermore, applications of the biochip's channel、the nanospline and the nanoarray dots for high-density optical storage system have been achieved using SPM-based nanomachining.
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