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Nanocutting of Monocrystalline Silicon Carbide

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Monocrystalline silicon carbide is a promising material for advanced components and devices, because it has very strong covalent bonding and presents excellent properties such as ultrahigh hardness (25~30 GPa), very low coefficient of thermal expansion (~4 × 10-6 /K) and outstanding thermal and chemical stabilities. However, these superior properties have also made SiC a difficult-to-machine material. This presentation will discuss our recent investigations into the deformation mechanisms of a SiC under nanocutting with the aid of large-scale molecular dynamics analysis. We studied six typical combinations of cutting plane and direction were studied, namely, (0001) < 1120 >, (0001) < 1100 >, (1120) <1100 >, (1120) < 0001 >, (1100) < 0001 > and (1100) <1120 >. We found that the cutting-induced deformation morphology, activated dislocations and cutting forces varied significantly under different combinations of cutting conditions due to the strong anisotropy effect of the material. By evaluating the actual depth of cut, elastic recovery, surface roughness and maximum subsurface damage depth, we identified that the basal plane (0001) along < 1100 > direction is the most suitable combination for nanocutting.