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Effect of low temperatures on tensile properties of ultrathin copper films[1] QIAO-NENG GUO, School of Physics & Engineering, Zhengzhou University, Zhengzhou 450052, China, ERNIE PAN, Computer Modeling and Simulation, University of Akron, Akron, OH 44325, USA, SHI-E YANG, MINGXING WANG, QIANG SUN, JIE-FANG WANG, YU JIA, School of Physics & Engineering, Zhengzhou University, Zhengzhou 450052, China — The recent developments in MEMS have created a requirement for comprehending the mechanical properties of copper thin films. Moreover, the serviceability temperature of the films used for space research, superconductivity and so on is mainly low temperature. Thus, the molecular dynamics is employed to simulate the mechanical responses of single-crystal copper thin films under uniaxial tensile loading in different low temperature environments. With varying applied temperatures to the thin films, the variation of the maximum stress, Young's modulus and maximal potential energy is characterized and three different deformation mechanisms in the low temperature range from 40 to 250 K are identified. These different mechanisms of copper films in different temperature ranges are then explained via the continuum damage mechanics based on the evolutionary features of the slip and twin in the thin film. It is concluded that at temperatures above 200 K normal slip process occurs; whereas at temperatures below 70 K, twin nucleation process appears. However, when the temperature is between 70 K and 200 K, both twin and slip processes happen.

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Qiao-Neng Guo
School of Physics & Engineering, Zhengzhou University, Zhengzhou 450052, China

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