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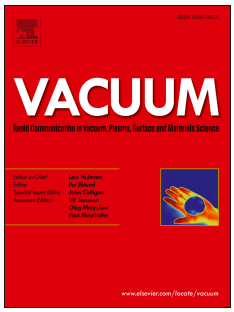

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Improvement of tribological properties of niobium nitride films via copper addition

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Abstract: Niobium nitride and copper (NbN-Cu) composite films with different copper content (Cu/(Nb+Cu)=0.6 at.%-24.8 at.%) were deposited using magnetron sputtering, and the microstructure and tribological properties of the films were investigated. The results showed that the films exhibited a mixture phase of face-centered cubic (fcc) NbN, hexagonal close-packed (hcp)NbN and fcc-Cu. The addition of copper below 6.0 at.% dropped both friction coefficient (μ) and wear rate (*WR*) sharply. A further increase in copper content decreased the μ furtherly, while the decreasing in μ took sacrifice of *WR*. The addition copper of 6.0 at.% into the niobium nitride matrix could broaden the niobium nitride film's effective service temperature to 400 °C. The lubricating copper (<200 °C) and the tribo-phases of copper oxide and niobium oxide remained the value of μ at ~0.55 regardless of temperatures at the cost of the increase of *WR*.

Keyword: magnetron sputtering, niobium nitride film, copper, tribologcial properties

1. Introduction

Niobium nitride based films were originally used in Josephson tunnel junctions, hot electron bolometers and superconductor single photon detector, since those films exhibit some excellent superconducting properties [1]. In recently years, niobium nitride based films were considered as one of candidate materials in cutting tools due to some unique properties such as high hardness, good wear resistant, thermal expansion coefficient matching to tool steels [2-5]. Improvement of the mechanical