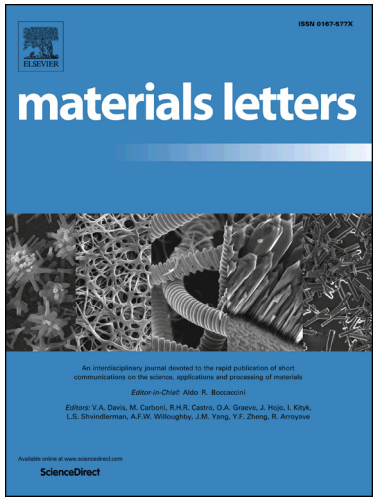

Effect of the nitrogen-argon gas mixtures on the superconductivity properties of reactively sputtered molybdenum nitride thin films

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Effect of the nitrogen-argon gas mixtures on the superconductivity properties of reactively sputtered molybdenum nitride thin films

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Abstract

We report on the superconducting properties of nanocrystalline molybdenum nitride thin films grown by reactive DC sputtering at room temperature with a N_2:Ar mixture. Thin films grown using 5 % N_2 concentration display T_c = 8 K, which is gradually reduced to 5.8 K for 30 % N_2 concentration, producing changes in nitrogen stoichiometry of the samples from Mo_2N to Mo_2N_{1+x} ($0 \leq x < 0.4$). The T_c is abruptly reduced and disappears for N_2 concentration between 30 % and 40 %, which can be attributed to an increment in the disorder due to phase coexistence between cubic γ-Mo_2N and non-superconducting amorphous MoN (dominant for N_2 concentration > 40 %).

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1. *Introduction*

Transition–metal nitrides (TMN) display a wide range of electronic and mechanical properties which are promising for technological applications. Superconducting TMN are potential candidates in a wide range of cryogenic devices like tunnel junctions [1] and electromagnetic radiation detectors [2]. The Mo nitrides present several superconducting crystalline phases: γ-Mo_2N (cubic) with T_c ~ 5 K [3], β-Mo_2N (tetragonal) with T_c ~ 5 K [4] and δ-MoN (hexagonal) with T_c ~ 12 K [5]. Different methods have been used in the growth of Mo nitride thin films, such as reactive sputtering [6,7], pulsed laser deposition [8], thermal nitration [9] and chemical routes [10]. A distinctive feature of γ-Mo_2N thin films is the influence of the disorder on T_c, which ranges from 4.5 K to around 8 K for epitaxial and polycrystalline thin films, respectively [11,12].

In this letter, we show that the T_c in γ-Mo_2N_x thin films (grown by reactive DC sputtering at room temperature) can be tuned by modifying the N_2:Ar mixture used during the sputtering process. T_c in thin films can be modified from 8 K to temperatures below 3 K by increasing the N_2 partial pressure in the N_2:Ar mixture from 5% to 40% of the total pressure. This modification can be associated with changes in the