Abstract of Presentation

$(Nb_{0.89}Al_{0.11})(O_{0.16}N_{0.84})$ oxynitride superconductor

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Abstract :

Metal oxynitrides are emerging functional inorganic compounds. Many researches have been performed to develop new oxynitride phosphor materials to realize white light emitting diode using their nephelauxetic effect and thermal stability due to their covalent chemical bond nature [1]. Tantalum oxynitride perovskites are potential lead free-dielectric materials having large dielectric constants independently on temperature [2]. Most of them have been prepared by ammonolysis in solid state reaction. Recently we have been prepared many kinds of new oxynitrides through citrate route [3, 4, 5]. Citric acid was added as geling agent to mixed metal nitrate aqueous solution. Its prefired amorphous oxide mixtures were nitrided in ammonia flow.

New oxynitride superconductor was found out in Nb-Al quarternary system [6, 7]. Single phase product was obtained at Nb/Al = 1 starting composition in the as-nitrided product. It crystallized in rock-salt type crystal structure but its crystallinity was not so well. It showed a superconductivity with Tc = 10 K and its volume fraction was several %. Various kinds of its post annealing were studied to improve the crystallinity. α-Al_2O_3 impurity appeared in the annealing.

The annealed product at 1500℃ for 3 hrs in 0.5 MPa N_2 showed a relatively good crystallinity contaminated with a small amount of α-Al_2O_3 impurity even at Nb/Al = 3 starting composition. Its neutron diffraction data was analyzed as $(Nb_{0.89}Al_{0.11})(O_{0.16}N_{0.84})$ by Rietveld refinement in $F_{m\text{-}3m}$ with a = 0.4403 nm as shown in Fig. 1. The annealed product prepared with its adjusted starting composition showed a superconductivity with Tc = 17 K and its volume fraction of 91% as depicted in Fig. 2.

Volume fraction was increased to 23% even in the as-nitrided product $(Nb_{0.60}Al_{0.08}\square_{0.32})(O_{0.21}N_{0.79})$ prepared by adjusting the starting composition. The amounts of oxygen and nitrogen in the annealed product was comparable to those of aluminum and niobium, respectively. The aluminum content may suggest that an $(AlO)^+$ unit substitutes one eighth of NbN units in the host crystal lattice forming a $2\times2\times2$ superlattice. The codoping of aluminum and oxygen leads to the highest Tc values among the known NbN related superconductors.

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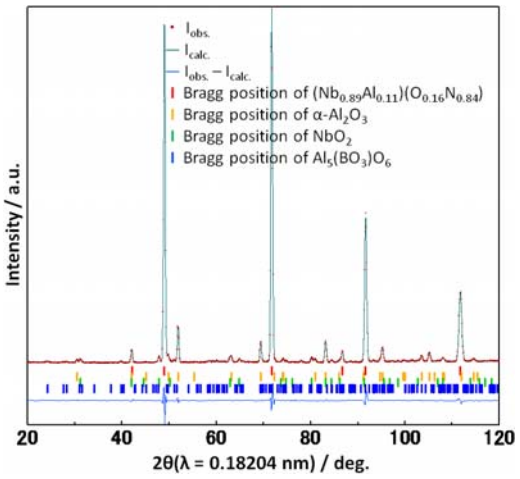

Fig. 1 Rietveld refinement of the ND pattern for the post-annealed $(Nb_{0.75}Al_{0.25})(O,N)$ product. The secondary phases, α-Al_2O_3 (hexagonal *R-3c*), NbO_2 (tetragonal *P4₂/mnm*), and $Al_5(BO_3)O_6$ (orthorhombic *Cmc2₁*), were also included in the refinement. The R_{wp} and S values were 4.88% and 1.33, respectively.

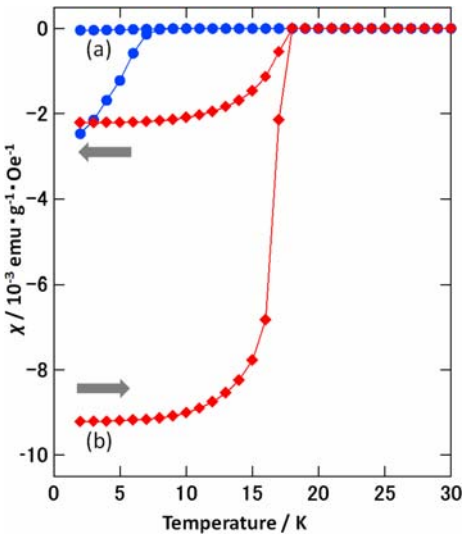

Fig. 2 Temperature dependence of magnetic susceptibility (χ) for the (a) as-nitrided and (b) post-annealed $Nb_{0.89}Al_{0.11}$ oxynitrides.

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