

SUPERCONDUCTING AND TRANSPORT PROPERTIES OF NbTi LAYERED METALS[†]

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We report data on the superconducting transition temperature and room temperature resistivity of layered NbTi for thicknesses in the range 7 - 70 Å.

I. Introduction

Layered metals have recently attracted considerable attention due to the possibility of fabricating new materials with unusual, tunable physical properties (e.g. mechanical¹, magnetic², or superconducting³). We report measurements on the superconducting transition temperature and electrical resistivity for the NbTi system.

Equal layer thickness (7-70Å) Nb/Ti specimens ($\sim 2\mu$ total thickness) were prepared on 90° sapphire substrates using a sputtering technique described earlier.⁴ The composition wavelengths (i.e. 2 x layer thickness) are obtained from the positions of the x-ray satellites (up to third order) associated with the Bragg peaks using a standard θ -2 θ diffractometer scan about the substrate plane normal.⁵ Nb (bcc) and Ti (hcp) deposit in a (110) and (0001) texture respectively. The interplane spacing of Nb (110) is 2.334Å; for Ti the (0001) hcp spacing is 2.342Å and the metastable (110) bcc spacing is 2.355Å. Thus a θ -2 θ diffractometer scan about the normal to the substrate provides insufficient information to uniquely characterize the structure in the Ti rich regions of a given layer. To obtain further information, transmission Laue photographs were taken on a sample which was stripped off the sapphire substrate; it showed the presence of several rings. The observation of rings rather than spots implies the presence of a texture rather than epitaxy with the grain size of the crystallites small on the scale the x-ray beam diameter ($\sim 0.020''$). Three of these rings correspond to the (211), (310) and (011) (and equivalent) planes of the bcc structure with a (110) plane normal. A fourth ring could not be indexed with a plane of the bcc or hcp structures assuming (110) or (0001) plane normals respectively (the diffractometer scan showing the presence of no other textures). This ring does index with a (111) plane of the fcc structure assuming a (111) plane normal. A diffractometer scan with the film rotated to place the other (111) plane normal to the θ -2 θ scan axis yielded a plane spacing consistent with a fcc structure having the same interatomic distance (2.342Å) as the Ti hcp structure. Since it is well known⁶

that many of the bcc transition metals adopt fcc structures in thin films we presumably have some fcc Ti. A diffractometer scan with the film rotated such that the (011) plane of the hcp structure was normal to the scan axis showed the presence of a small amount of hcp Ti. In summary the structural study indicates that most of the Ti is in the bcc phase.

Transition Temperature Measurements

Superconducting transition temperature measurements were performed on all samples using an ac mutual inductance bridge with the oscillating field applied parallel to the film. In addition the transition was studied resistively in four samples. Fig. 1 shows the observed transition temperatures for the samples having

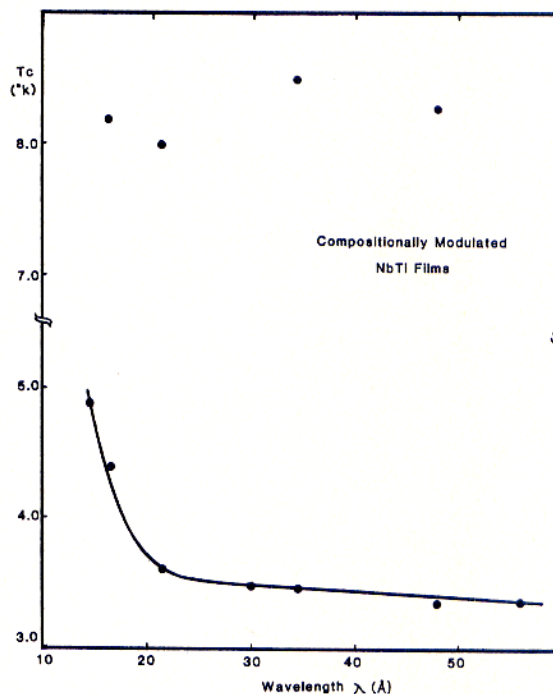


FIGURE 1 The dependence of the observed superconducting transition on composition wavelength; the dominant transition occurs at the lower temperature.

