Growth of Uniaxially Oriented Nickel Aluminum Superalloy Films for Spectroscopic Infrared Emitters

International Center for Materials Nanoarchitectonics, National Institute for Materials Science [1], Department of Condensed Matter Physics, Graduate school of Science, Hokkaido University [2]

◦(D)Toan Phuoc Tran[1,2], (D)Thien Duc Ngo[1,2], Tadaaki Nagao[1,2]

E-mail: NAGAO.Tadaaki@nims.go.jp

We report uniaxially oriented nickel aluminum (NiAl) superalloy films grown by DC magnetron sputtering under *in situ* heating, followed by subsequent reactive ion etching to fabricate spectroscopic mid-infrared emitters. We adopted NiAl – Al_2O_3 – NiAl trilayers design where the top NiAl strips acts as infrared resonators with their resonance wavelengths also matching to the periodicity of the NiAl strips. The films self-organize in (110) orientation with relatively low surface roughness and tight grain boundaries in columnar structure. The plasmonic performance of the NiAl absorbers (NAs) was found to be comparable to that of a NiAl single crystal and exceeds those of conventional refractory materials (molybdenum, tungsten, titanium nitride) in the visible to the NIR region (Fig. 1 (b)). The fabricated NAs that followed the simulated design exhibited excellent resonant absorption (absorptivity ≈ 92%) and single-band emission, as well as good resonance tunability by changing the periodicity and the width of the NiAl strips. This work paves the way to superalloy-based plasmonic photothermal energy applications.

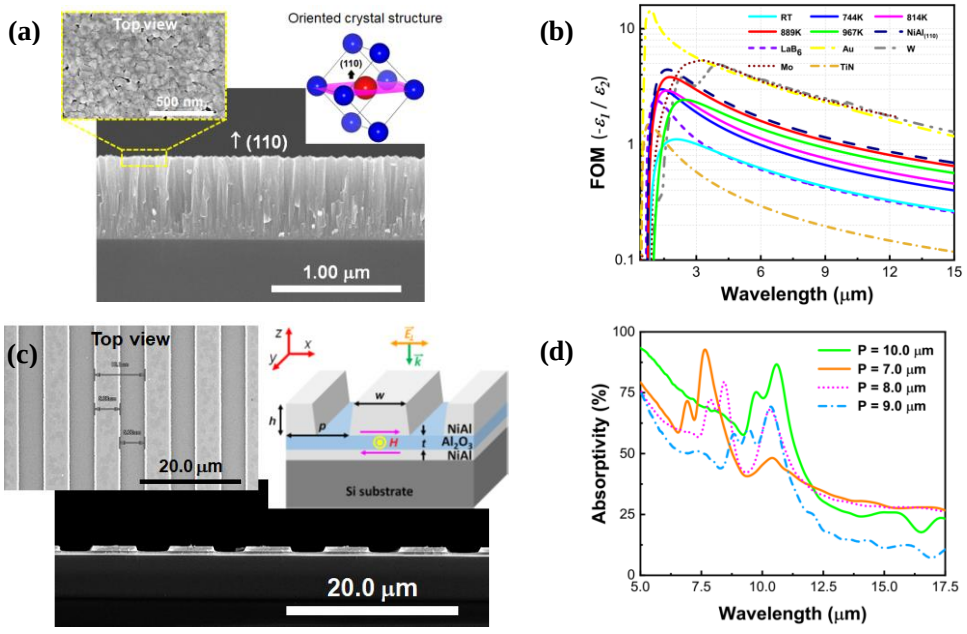

Fig. 1. (a) SEM images of sputtered NiAl film (surface and body-morphology with oriented crystal structure). (b) Figure of merit (FOM) of NiAl films compared to other materials. (c) NiAl-MIM resonators consisting of NiAl strips, an Al_2O_3 insulator, and a NiAl:Si back reflector. Schematic of the incident electromagnetic fields propagate along the *Z*-axis and the electric field is polarized in *X* ($\vec{E}_{\perp}$) direction and (d) experimental absorptivity of NiAl-MIM by changing periodicity *p*.

© 2022年 応用物理学会