Preferential atomic deposition and diffusion in multi-layered NiTi thin film

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Introduction

Now-a-days Ni-Ti thin film shape memory alloy has attracted much research in the micro device industry due to its interesting mechanical properties. The work output of thin film is superior having the excellent chemical resistance, biocompatibility, which leads to the development of exciting industrial applications. To fulfil all the demand of durability, mechanical stability, dynamical coupling, chemical and physical compatibility, nanostructure multilayered thin film going to be a demanding objective.

Experimental Design

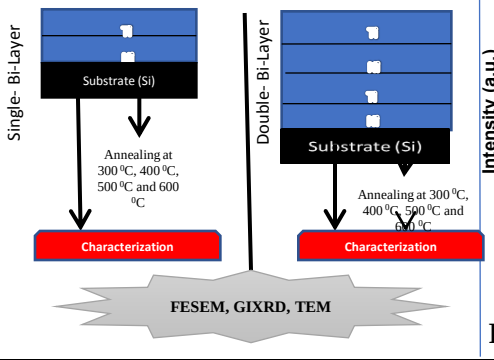

Table 1: Sputtering process Parameters.

Deposition Parameters	Values
Partial Gas Pressure (Ar)	5 mTorr
Gas flow rate	50 sccm
Substrate-to-target distance	125 mm
Substrate temperature	300 ºC
Substrate biasing	-50 V
Substrate rotation	10 rpm
Base vacuum	10^{-6} Torr
DC power for Ni	≈ (71-72) W
RF power for Ti	≈ 300 W

Results

GIXRD Analyses

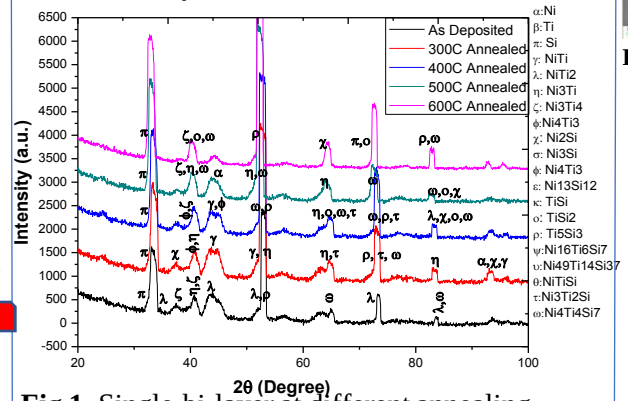

Fig 1. Single-bi-layer at different annealing.

Surface morphology

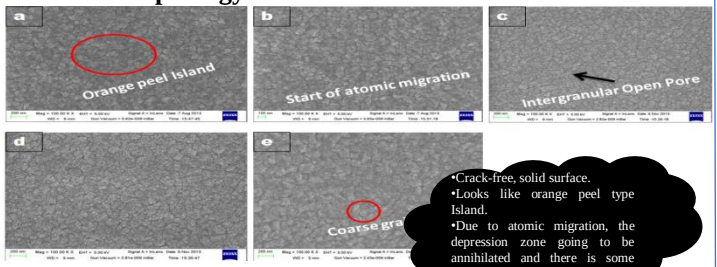

Fig 2. Surface morphology of single-bi-layer [illegible], and annealed at (b) 300 ºC, (c) 400 ºC, (d) 500 ºC, (e) 600 ºC.

Interface morphology

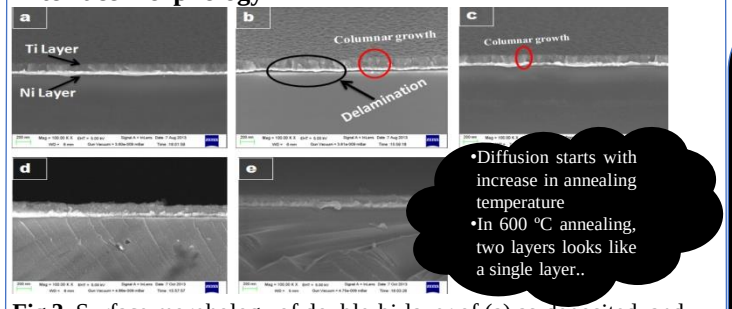

Fig 3. Surface morphology of double-bi-layer of (a) as-deposited, and annealed at (b) 300 ºC, (c) 400 ºC, (d) 500 ºC, (e) 600 ºC.

TEM Analysis

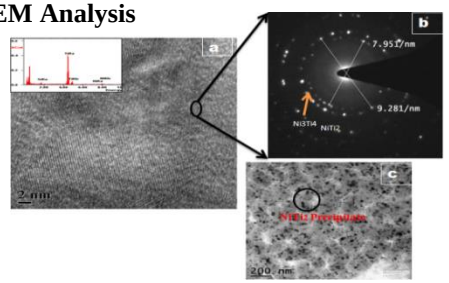

Fig. 4 Phase analysis of single-bi-layer annealed at 600 ºC.

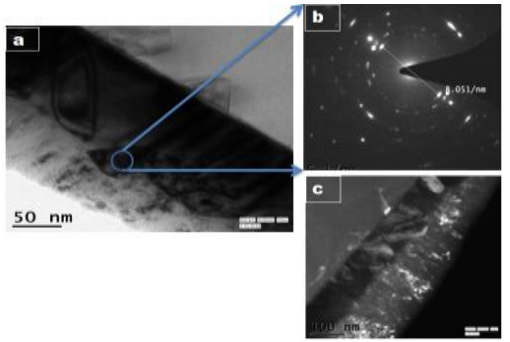

Fig 5. (a) shows a Cross sectional image, (b) shows the ring pattern of the surface, and (c) shows BF image of Ni-Ti single bi-layer.

Conclusions

- Intermetallic phases formation with little amount of ternary silicide.
- As-deposited sample contains NiTi, Ni_3Ti_4, Ni_3Ti, $NiTi_2$, $Ni_4Ti_4Si_7$.
- In 300 ºC annealed sample; additional Ni_4Ti_3 and Ni_3Ti_2Si are present.
- In both 400 ºC and 500 ºC annealed sample, there is nearly same phases present.
- NiTi grows along (111) plane.
- In all annealing cases, most of the peak are sharp, indicates towards the development of crystalline structure.

References

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