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Evolution of stress in thin hard films by surface Brillouin scattering

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1. Introduction

Transition metal based thin films continue to attract tremendous research interest due to their excellent properties. As such they are widely used as protective coatings in optics and cutting tools due to their chemical properties, low wear and tear under extreme environments [1]. However delamination and intrinsic stress remain a great challenge especially in multilayer thin films. The mechanisms of thin film growth and intrinsic stress can be understood by investigating stress evolution through modification of elastic constants after insitu Ar+ incorporation during film growth. In this work, we present an alternative approach to investigate stress evolution of either crystalline or amorphous thin hard films using the components of the elastic constant tensor. Thin films of transitional metal carbide on etched (100) Si substrates have been grown by RF magnetron sputtering at 0 and - 60V bias to observe stress evolution by surface Brillouin scattering. A RF power of 175W and Ar2 working gas pressure of 1.0 x10-3mbar were used for film synthesis. X-ray Reflectometry has been used extract the film growth rate from measurements of film thickness, interfacial roughness and density. The density values were used to extract and simulate velocity dispersion curves obtained from surface Brillouin scattering spectra. A low surface roughness has been determined by X-ray Reflectometry for all films to ⊠ 1.5 nm. Surface Brillouin studies on the - 60V biased and pristine samples have shown the propagation of Rayleigh surface acoustic wave and higher frequency peaks. The presence of the high frequency shift indicates a high film quality. The velocity dispersion curves show an increase in surface acoustic phonon velocity corresponding to an increase in elastic constants upon biasing. It is observed that Ar+ incorporation changes the C33 elastic constant by 38% with a resulting columnar thin film growth from the C11/C33 <1 values.

1. Results

Fig 1 shows the typical surface Brillouin scattering spectra of transitional metal carbide. The true surface acoustic wave and the higher frequency peaks (Sezawa waves). The evidence of stress evolution is presented in Fig 2 which depicts an increase in the surface acoustic phonon velocity of the irradiated samples.

1. References

[1] A. Palmero, E.D. van Hattum, W.M. Arnoldbik, F.H.P.M. Habraken, Surface & Coatings Technology 188-189, 392 (2004).

Are you currently a postgraduate student? (Yes/No)

No

At what level of studies are you currently? (Hons/MSc/PhD)

none

Primary author: Dr WAMWANGI, Daniel (wits university)

Co-authors: Mr SUMANYA, Clemence (DST/NRF Centre of Excellence in Strong Materials); Prof. COMINS, Darrell (University of the Witwatersrand)

Presenter: Dr WAMWANGI, Daniel (wits university)

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