TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Why does dislocation climb makes thin films harder?

Citation for published version (APA):
Ayas, C., Deshpande, V. S., & Geers, M. G. D. (2010). *Why does dislocation climb makes thin films harder?*. Poster session presented at Mate Poster Award 2010 : 15th Annual Poster Contest.

Document status and date:
Published: 01/01/2010

Document Version:
Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

• A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
• The final author version and the galley proof are versions of the publication after peer review.
• The final published version features the final layout of the paper including the volume, issue and page numbers.

Link to publication

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.tue.nl/taverne

Take down policy
If you believe that this document breaches copyright please contact us at:

openaccess@tue.nl

providing details and we will investigate your claim.

Download date: 04. Oct. 2023

Technische Universiteit Eindhoven University of Technology

Why does dislocation climb makes thin films harder?

C. Ayas, V. Deshpande, M.G.D. Geers

1. Introduction

Metallic thin films on the order of (sub)-micrometers are one of the main building blocks of various small electronic devices. Their reliability is intimately tied to the mechanical properties at this length scale. Discrete Dislocation Dynamics (DDD) framework in contrast to conventional continuum theories is an accurate modelling tool on the order of micrometers to study plastic deformation by way of individually taking dislocations into consideration. In this study we incorporate the dislocation climb mechanism to DDD framework and investigate climb assisted dislocation glide. This allows to study complex time-dependent processes in precipitation-hardened thin Al-Cu films.

2. Problem Description

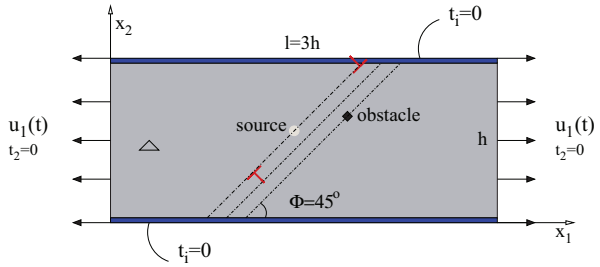


Figure 1: Schematic illustration of 2D plane strain problem. Single crystal is stretched in uniaxial tension.

Passivation layers are present at the top and bottom. where friction stress τ_f is counteracting on the resolved shear stress τ^{ϕ} which drives dislocation motion. Dislocation I gets stuck at the interface until $\tau^{(I)} \geq \tau_f$.

3. Stress vs. Strain Response

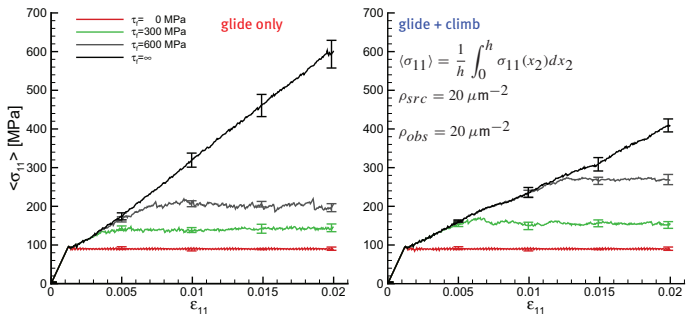


Figure 2 : Stress strain curves for $h = 0.5\ \mu m$.

4. Dislocation Structure & Stress

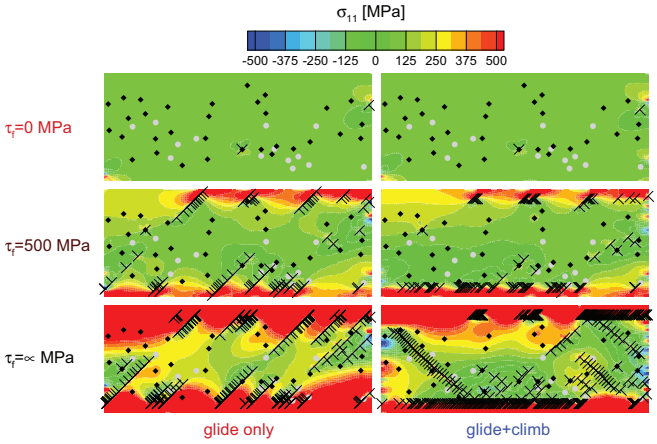
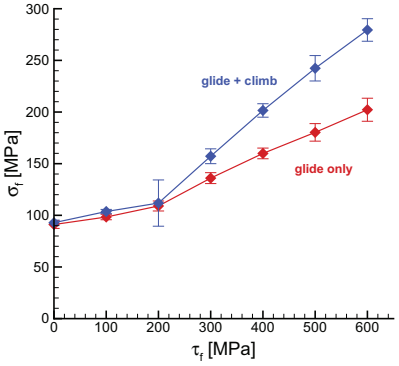


Figure 2: σ_{11} distribution across the film and superimposed dislocation structure.

- In climb assisted glide dislocations do not form pile-ups at hard boundaries but instead spread out of their original slip plane. Dislocation walls are formed.

- When climb mechanism is present at a finite τ_f, few dislocations can exit from the surface due to lower local stress at the interface.



5. Conclusion

For self passivated thin films (e.g. Al-Cu), climb assisted glide gives a harder stress response, i.e. higher σ_f when compared to glide only cases. The effect of film thickness h on climb assisted glide is the focus of our ongoing research.