CHARACTERIZATION OF THIN FREE-STANDING AL-MG FILMS

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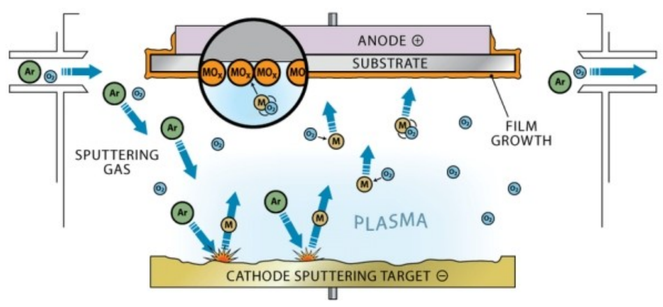
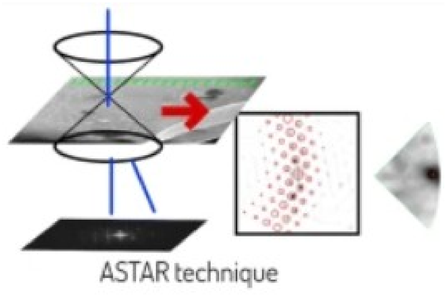
Motivation

Small-scale thin films are frequently used in microelectronic devices and micro-electro-mechanical systems where they are commonly subjected to high strains during their dynamic motion. However, mechanical behavior of thin films significantly differs from the behavior observed in bulk materials. To understand the size dependent properties of deformation mechanisms, characterization of the grain properties of nano-scale materials is essential along with mechanical tests.

Experimental

Thin free standing films were prepared from DC magnetron sputtered samples by dissociating the films from a glass substrate covered by photoresist. 50 nm, 100 nm and 150 nm thick films were prepared from an AlMg target.



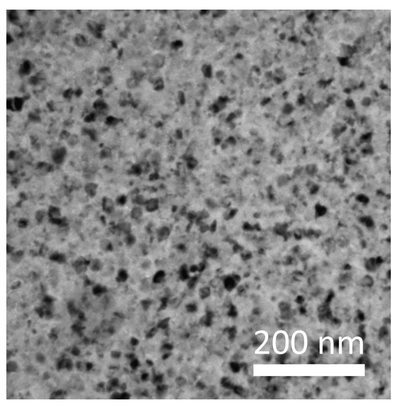


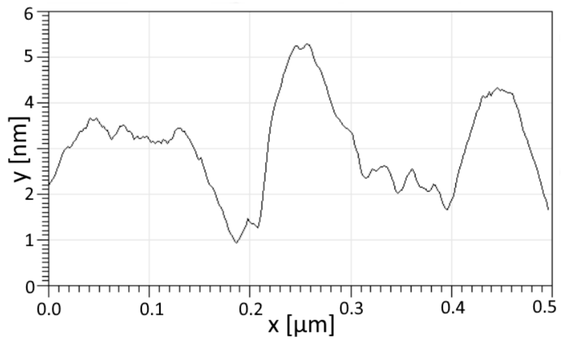
The films were characterised by AFM using Bruker Dimension Edge device in tapping mode, by TEM in BF and by Automated orientation phase mapping at TEM JEOL 2200FS equipped with “Spinning Star” electron precession with an ASTAR software package.

Results

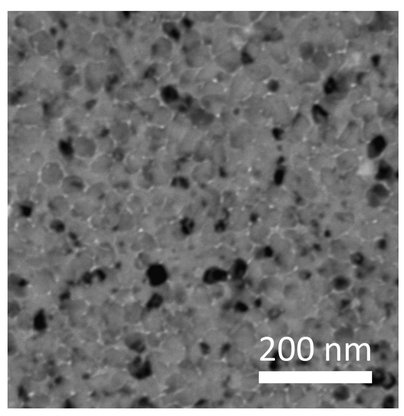
TEM

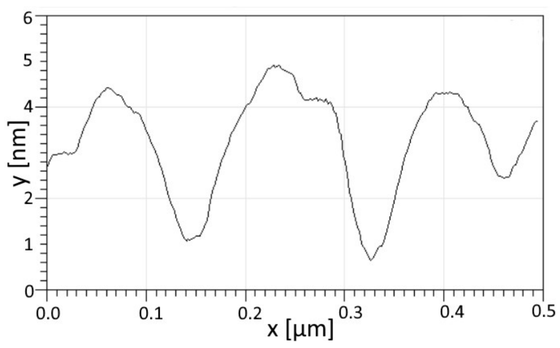
AFM – height profile



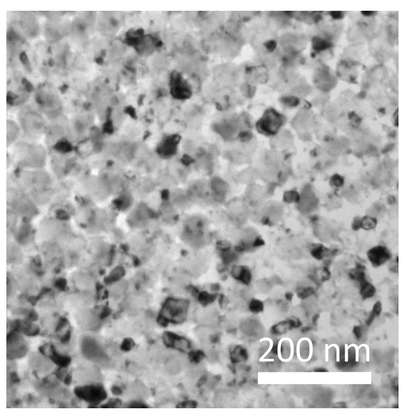


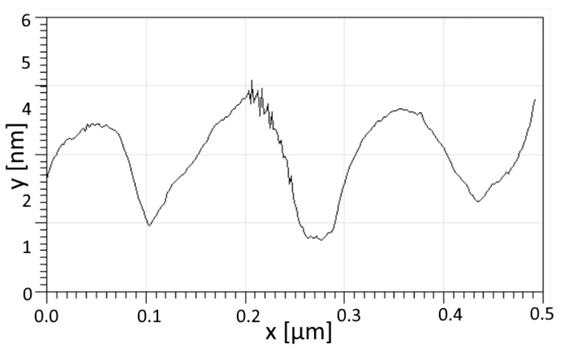
50 nm





100 nm



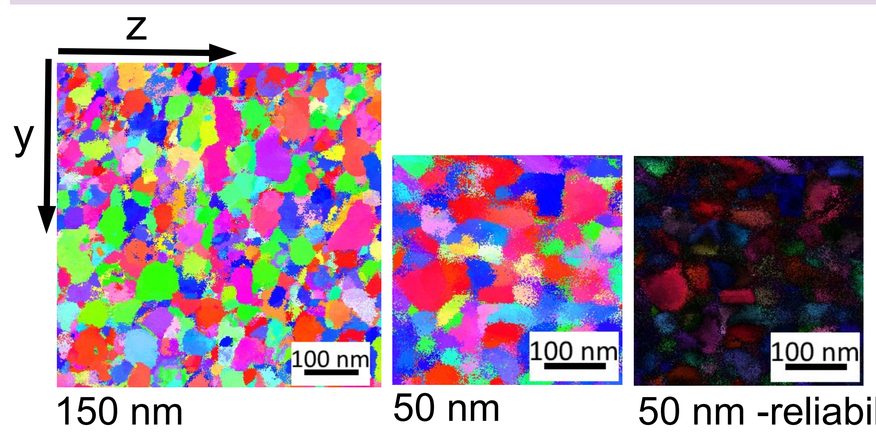


150 nm

Average grain size increases gradually with the film thickness from 30 nm for the 50 nm thick films to 50 nm for 150 nm thick films.
AFM measurements show surface roughness in scale of tens of nm.

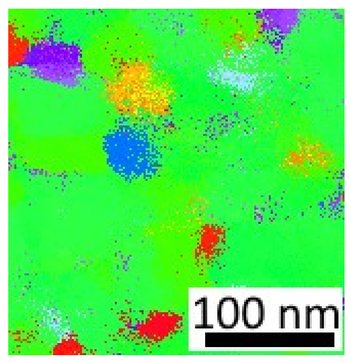
ASTAR

Grain orientation distribution is shown. The grain size for 150 nm thick film corresponds with the TEM BF measurements. For 50 nm thick films, the grains are larger. It is possible that several grains of the similar orientation are grouped together.



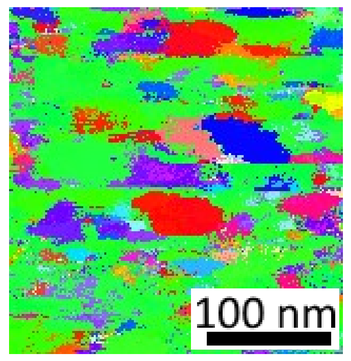
150 nm 50 nm 50 nm -reliability

The determination of grains size from orientation maps is difficult due to the large areas of low orientation reliability caused by the overlapping of neighbouring grains.

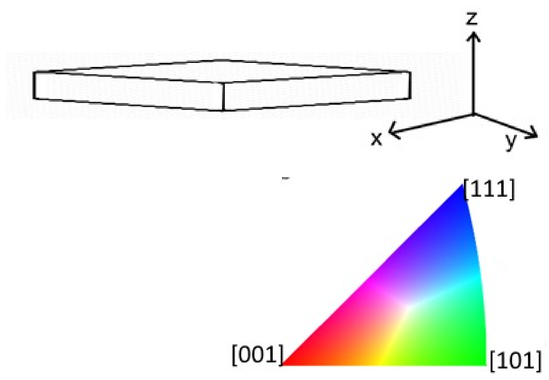


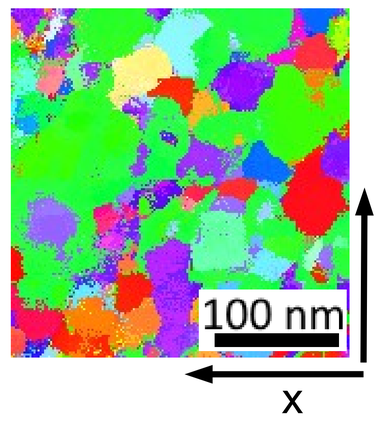
50 nm

Preferable orientation direction is [101] in the z direction perpendicular to the sample surface. Other two directions x,y do not show any preferable orientation distribution.



100 nm





150 nm

Summary

Preparation of thin Al films by DC magnetron sputtering onto a photoresist-covered glass substrate leads to evenly distributed grains with average size gradually increasing with the film thickness and direction [101] preferably oriented perpendicular to the sample surface.

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