

Surface Roughness and XRD Studies of Electron Beam Evaporated Mo and Er Films: correlation between substrate and process conditions

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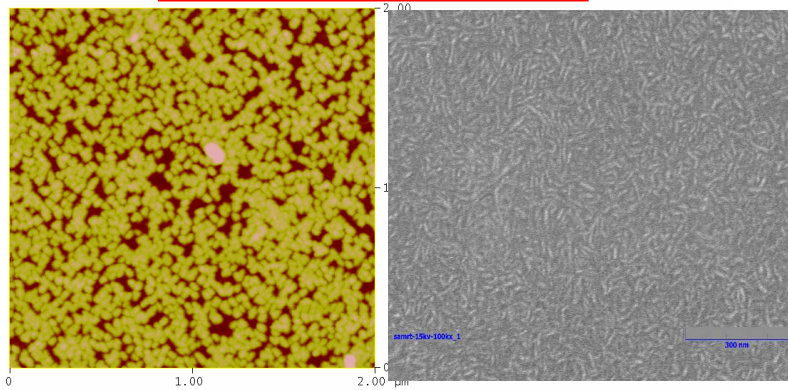
What do we measure

- Grain Size orientation - Texture
- Surface Roughness

Molybdenum deposited on (a) [1-102] Al_2O_3 , and (b) no-etched Mo @ 250°C

(a)

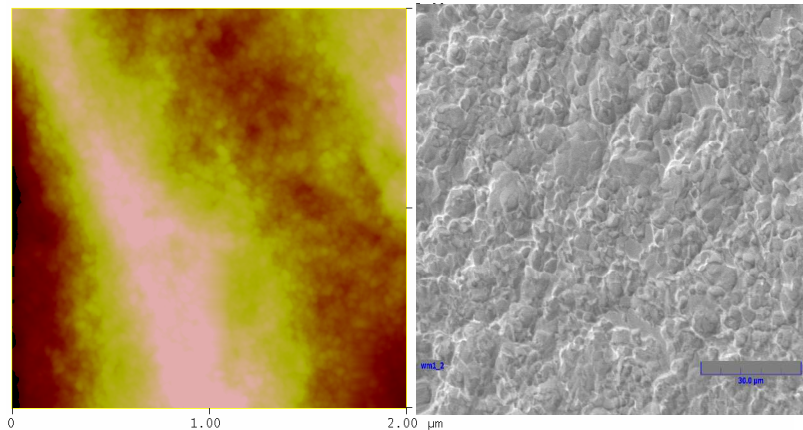
1 Å/s, RMS=41 Å



082106samo.001

Peak Surface Area Summit Zero Crossing Stopband Execute Cursor

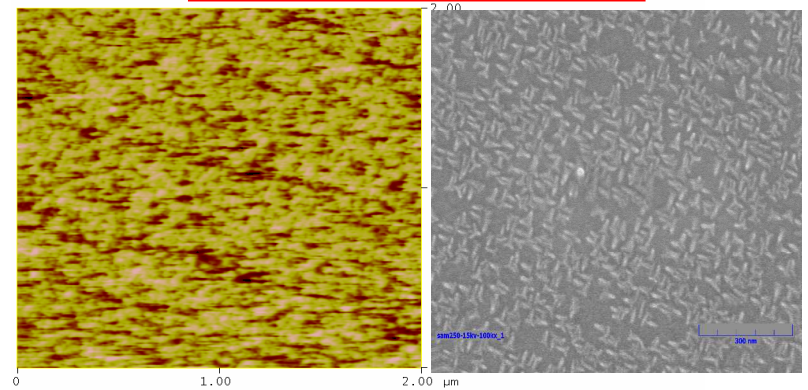
1 Å/s, RMS= 376 Å



082106wmo.001

Peak Off Summit Off Zero Cross. Off Box Cursor

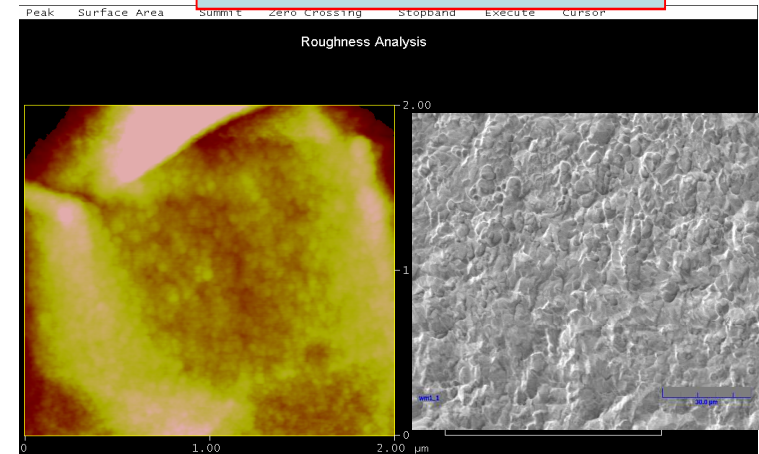
10 Å/s, RMS=26 Å



080806sap.001

Peak Off Summit Off Zero Cross. Off Box Cursor

10 Å/s, RMS=784 Å



081506w-mo.001

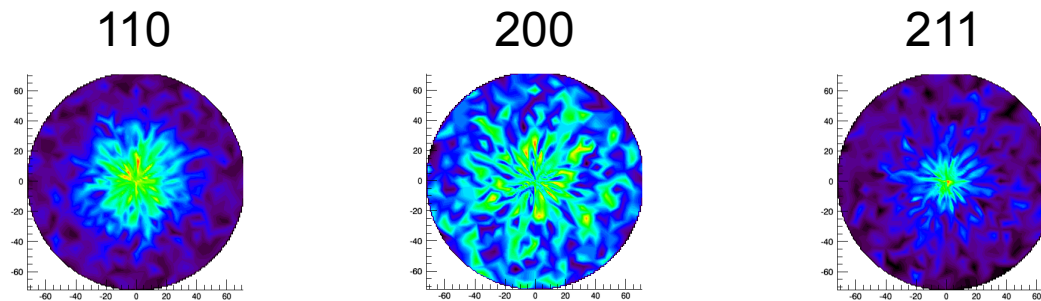
Peak Off Summit Off Zero Cross. Off Box Cursor

Summary of the influence of substrate roughness and deposition parameters on the film surface quality

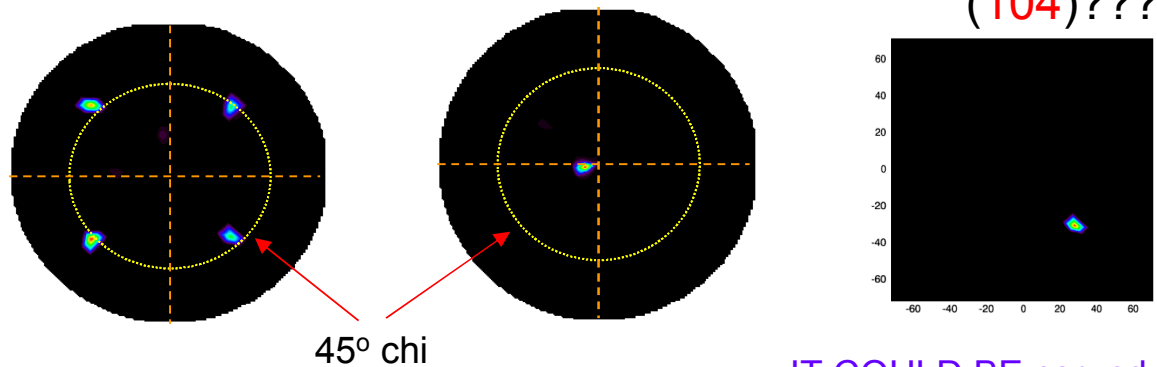
- The surface morphology of the films was observed by Atomic Force Microscopy (AFM) as well as Scanning Electron Microscopy (SEM).
- The Mo films were prepared at low deposition temperatures ($T/T_m=0.02-0.32$) consists of small round grains as observed by SEM. At low temperatures the surface mobility is reduced.
- The surface roughness measured using AFM shows that the surface roughness varies with substrate and deposition rate. A faceted film is observed when deposited at 10 \AA/s on sapphire. It is also obvious that depositing a film in a smooth surface reduces the surface roughness by a factor of ~ 30 .

Substrate Texture influence Mo films grain orientation

(a) Mo on Si (100), RT, 1000 Å, 1 Å/s



(b) Mo on Al_2O_3 [1-120], 250°C, 1000 Å, 1 Å/s

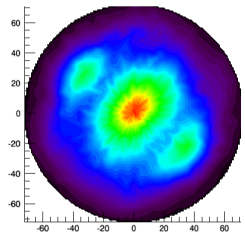


IT COULD BE corundum as it sits 47 deg out of plane from the (1-12) pole.

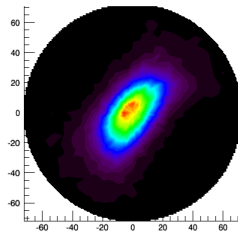
Summary of Mo deposited on Si(100) and [1-120] Al₂O₃

- (a) Mo deposited on Si(100) at room temperature appears to have bi-axial (110) out-of-plane texture.
- (b) Mo film deposited on sapphire at 250°C has out-of-plane (200) texture. In plane texture also present. Bi-axial Mo film on Al₂O₃ [1-102]

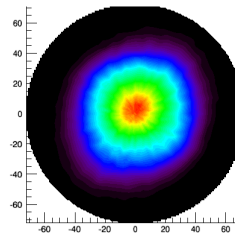
Er deposited on (a) rolled Mo no etched, (b) Mo etched,
(c) Mo on Sapphire [1-120]@RT
 $T/T_m=(0.02-0.32)$



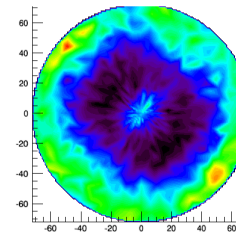
Mo (110)



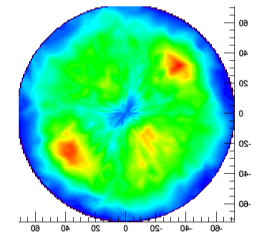
Mo (200)



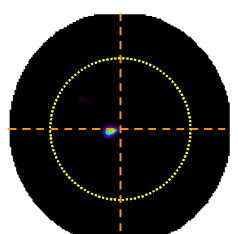
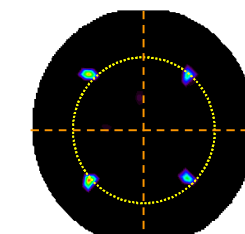
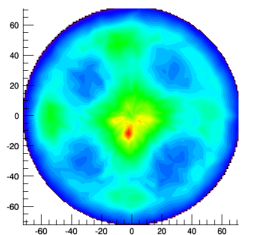
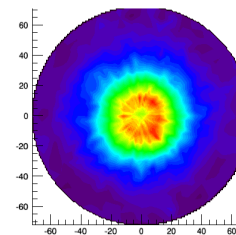
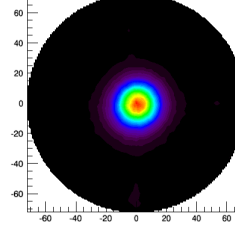
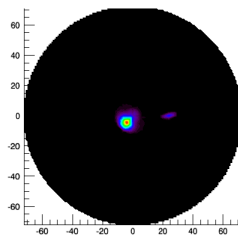
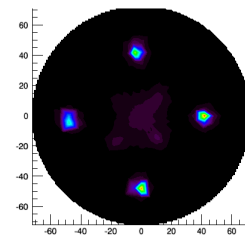
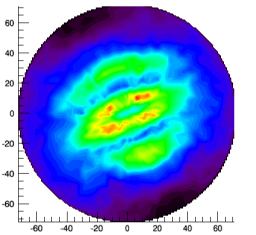
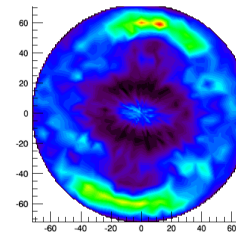
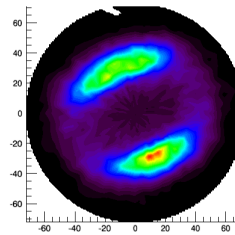
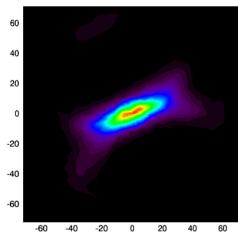
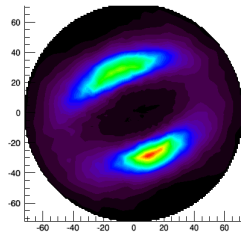
Er (002)



Er (100)



Er (101)



Mo on Al_2O_3 [1-120], 250°C, 1000 Å, 1 Å/s

Summary of Er deposited on Mo and Sapphire

- (a) Mo-no etched substrate shows both (110) out of plane and (200) out of plane rolling texture. Er (002) out of plane with hint of rolling texture
- (b) Mo-etched substrate has (200) out of plane rolling texture. Er (002) shows rolling texture. Is Er (002) growing epitaxial on Mo (110) ? Maybe
- (c) Mo film has clear out-of plane (200) bi-axial texture.
- (d) Er film appears to have biaxial texture with the (200) being out of plane.
- (e) The Er (002) does not appear to be growing epitaxially on Mo(110) this time perhaps because of the presence of Er_2O_3 ?

Questions/Future Work

- A systematic study to parameterize the growth mode as a function of substrate properties and growth conditions.
- Study the role of impurities (i.e. O_2) on film texture and residual stress