# Structural Changes and Dislocations of Rare-Earth Ferric Oxide Thin Films

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## Applications and Interests

Thin Films have a wide range of applications in materials science and energy sciences research.

Applications of thin films include metal coverings, lighting equipment, semiconductors, spintronics, solar cells, photoconductors, and power generation.

Rare Earth Ferric Oxides are an interest in thin film research as they are some of the most ductile materials, show permanent magnetism, and have electrical conductivity.

Scandium and Ytterbium Ferric Oxides are a growing part of research and have been shown to exhibit screw dislocations.

## Methodology

h-ScFe03 deposited onto Al203 substrate using Pulsed Laser Deposition (PLD).

h-YbFe03 deposited onto CFO/LSMO/SrTi03 substrate using Pulsed Laser Deposition (PLD).

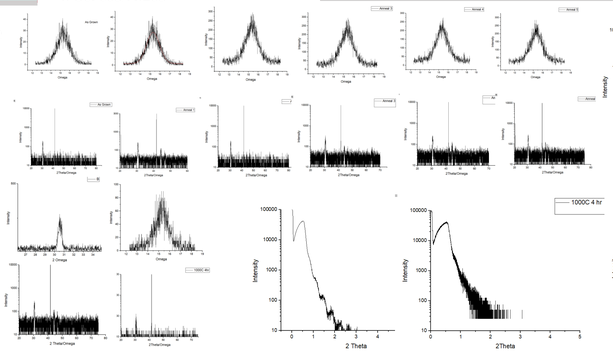
h-ScFe03 annealed between 900-1000 Celsius for varying time intervals (1,2,3,4,6 hours).

Thin Films were analyzed by Atomic Force Microscopy (AFM) to look at surface structure and dislocation.

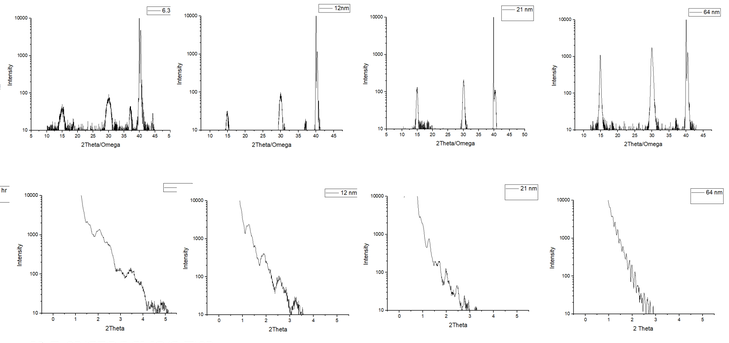
Thin Films were analyzed by X-Ray Diffraction (XRD) and X-Ray Reflection (XRR) using Rigaku SmartLab to search crystal structure changes and thickness.

## X-Ray Diffraction and Reflectivity

h-ScFe03/Al203



YbFe03/CFO/LSMO/SrTi03

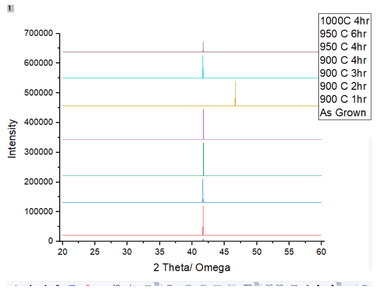


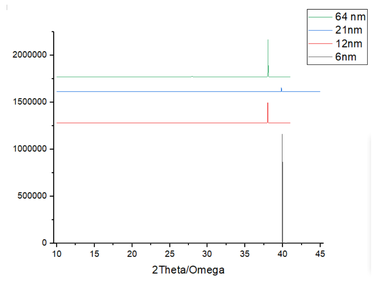

h-ScFe03/Al203



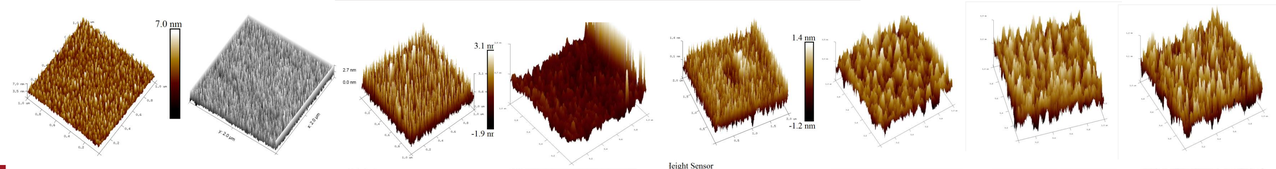

YbFe03/CFO/LSMO/SrTi03

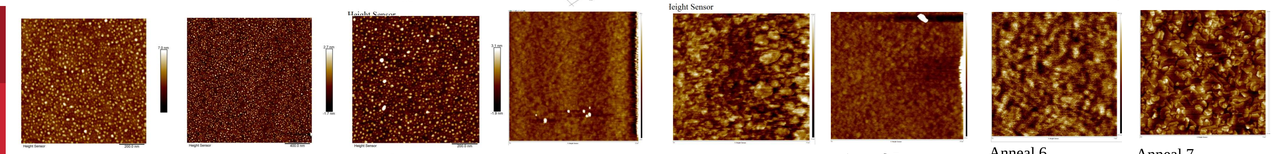



## AFM Analysis



As Grown
Rq 0.735 nm

Anneal 1
900 C 1 hour
Rq 0.438 nm

Anneal 2
900 C 2 hours
Rq 0.545 nm

Anneal 3
900 C 3 hours
Rq 0.585 nm

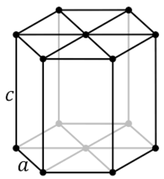
Anneal 4
900 C 4 hours
Rq 0.259 nm

Anneal 5
950 C 4 hours
Rq 0.565 nm

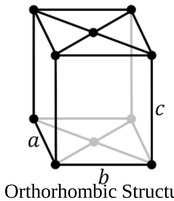
Anneal 6
950 C 6 hours
Rq 0.300 nm

Anneal 7
1000 C 4 hours
Rq 0.325 nm

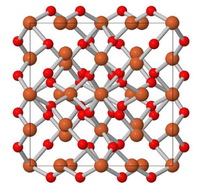
## Structures and Dislocations



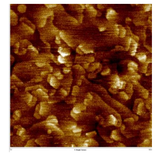

Hexagonal Structure

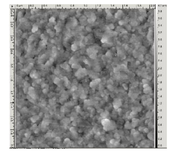


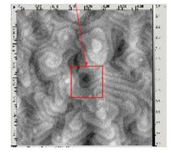

Orthorhombic Structure



Bixbyite Structure







Screw Dislocations on
1) h-ScFe03/Al203
2) h-YbFE03/CFO/LSMO/SrTi03
3) h-ScFe03/STO/LSMO

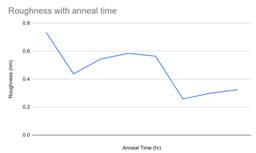
## Results

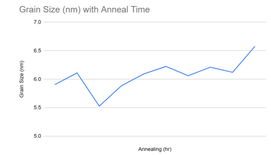
Screw Dislocation found on h-ScFe03/Al203 with step size around 600nm.

h-ScFe03 shows hexagonal phase with main peaks (004), (006), (008). Hexagonal phase remained with annealing intervals at 900 C for 1-4 hours, 950 C for 4-6 hours, and 1000C for 4 hours. No visible bixbyite change has occurred yet.

h-YbFe03 shows increase in intensity with thin film thickness.

Grain size of h-ScFe03 increased with annealing time, whereas roughness decreased.

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