Sol-Gel Processing of Ilmenite-Hematite Thin Films

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Abstract

A solid solution of ilmenite (FeTiO$_3$) and α-hematite (Fe$_2$O$_3$) is a possible ferrimagnetic semiconducting spintronic material according to density of state calculations (B. Butler A. Bandyopadhyay). Sol-gel synthesis of thin films allows for easy control of Fe:Ti ratios simply by varying the amounts of metal precursors. Since the sol-gel process produces porous films, a post deposition anneal treatment must be developed for device quality material.

Sol-Gel Method

Two different methods were employed for two types of iron precursors: FeCl$_3$ and Fe(NO$_3$)$_3$.

Ti precursor for both methods was Ti (IV) isopropoxide

FeCl$_3$ method:
- Dissolved 2.275g FeCl$_3$ in 15 mL of ethanol
- Stir the mixture for 10 minutes
- Slowly add 5 mL titanium (IV) isopropoxide.
- Stir mixture INTENSIVELY for 10 minutes
- Spin coat the solution at 4000 rpm for 30 seconds.
- Anneal the films at 300°C and 500°C for two hours.

Fe(NO$_3$)$_3$ method:
- Dissolve 5mL titanium (IV) isopropoxide & 4.063g Fe(NO$_3$)$_3$ in 15 mL ethanol
- Stir the solution for one hour
- Spin coat the solution at 4000 rpm for 30 seconds.
- Anneal the films at 300°C and 500°C for two hours.


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