AQUEOUS COMBUSTION SYNTHESIS OF AlO_x FOR APPLICATION AS GATE DIELECTRIC IN SOLUTION-PROCESSED TFTs

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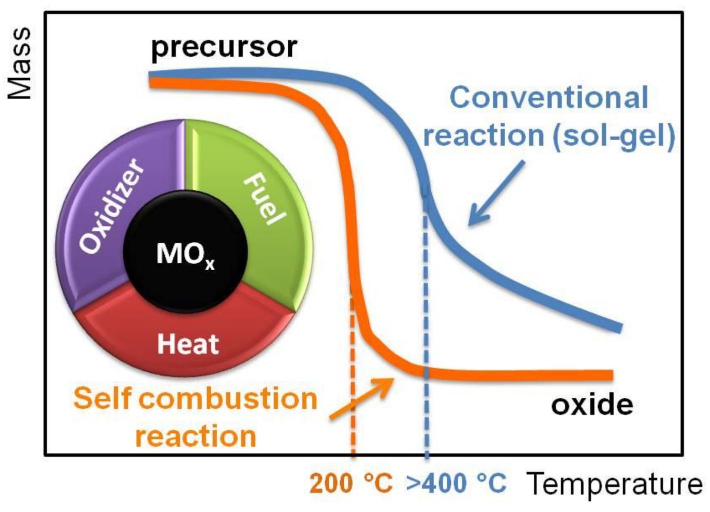
INTRODUCTION

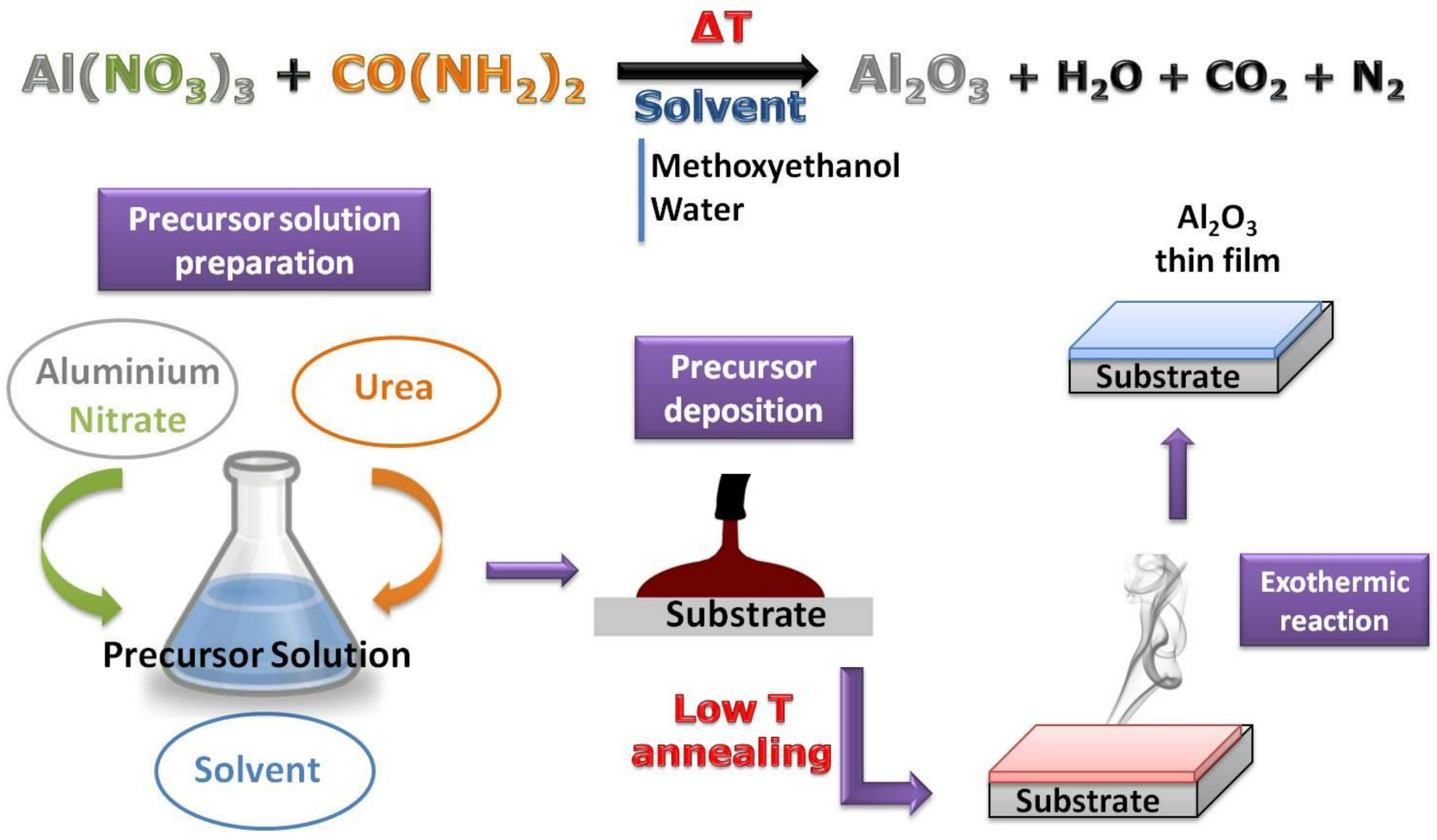
Solution based fabrication methods and materials have been pursued as an alternative for economically viable large-scale electronics.

Self-combustion solution synthesis takes advantage of the chemistry of the precursors as a source of energy for localized heating. The exothermic reaction generates energy that can convert precursors into oxides at low process temperatures [1,2]. Theoretically this reaction mechanism can be applied to any metal ion to produce the desired oxide.



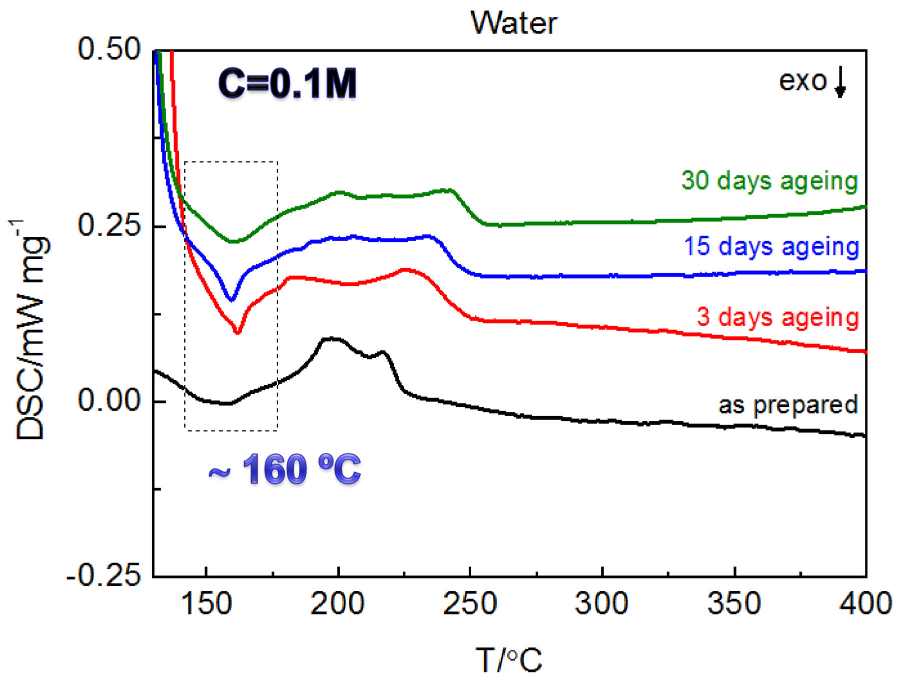
In this work we present a study on the solution combustion synthesis of AlO_x in water and in 2-methoxyethanol by using urea as an oxidant and varying the precursor solution aging time and the initial concentration of the metal ion. Optimized aqueous-based AlO_x were used as a gate dielectric in solution processed GZTO semiconductor yielded solution processed TFTs with low hysteresis; μ_{SAT}=1.3 cm²/V.s; S=0.30 V/dec; V_T=0.8 V; I_{ON}/I_{OFF}=8.7x10⁴ [3].

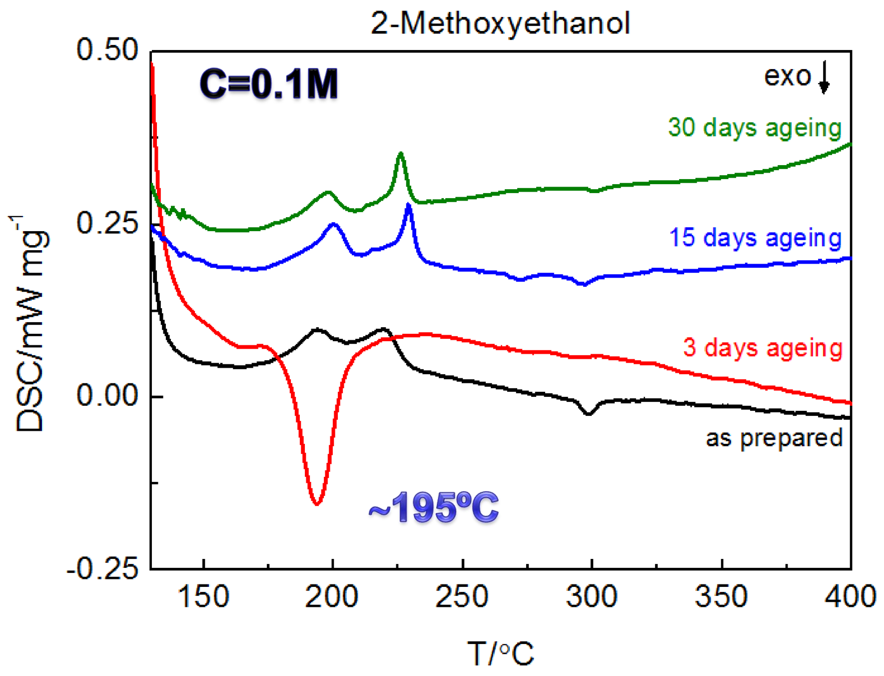
Al_2O_3 COMBUSTION SYNTHESIS



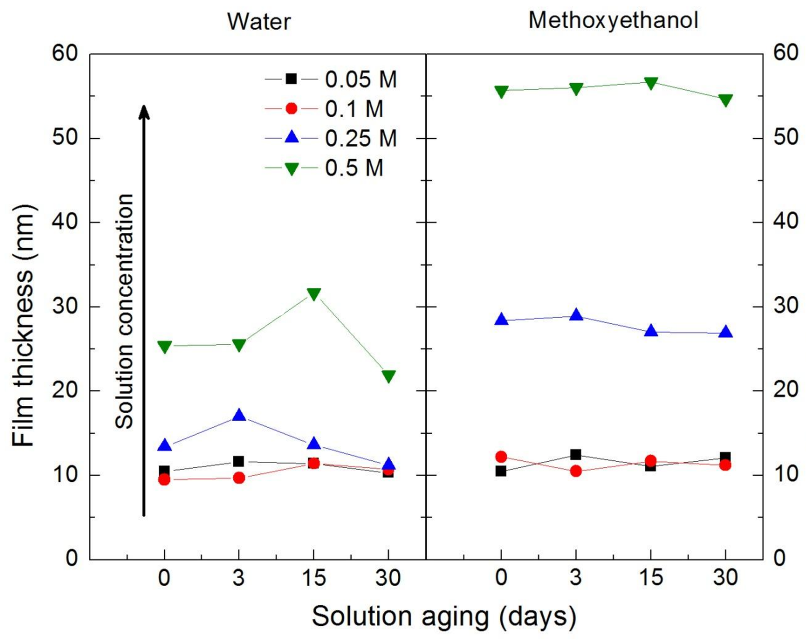
SOLUTIONS AND THIN FILMS CHARACTERIZATION

Precursor Solution DSC



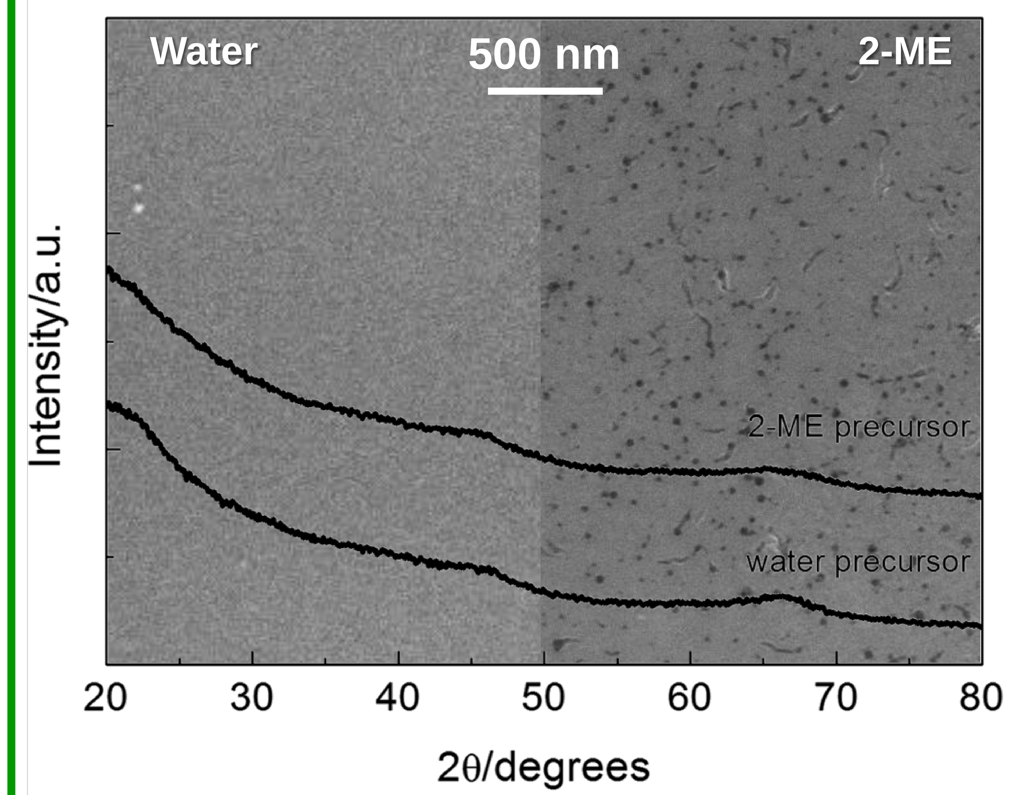


Film thickness variation



DSC
Lower synthesis T with less dependance on solution ageing time for water precursors.

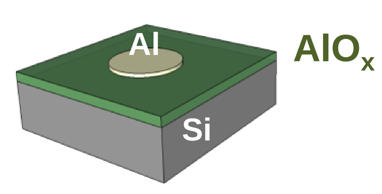
XRD & SEM



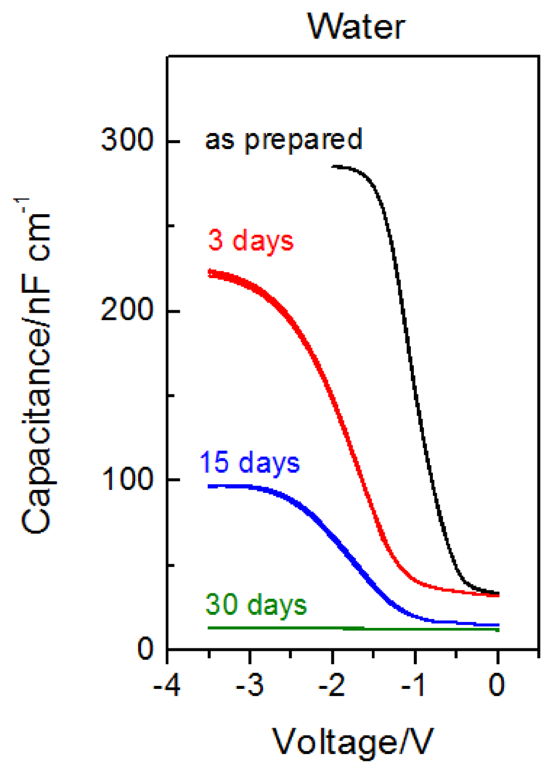
The films are amorphous.
Water yields smoother uniform films.

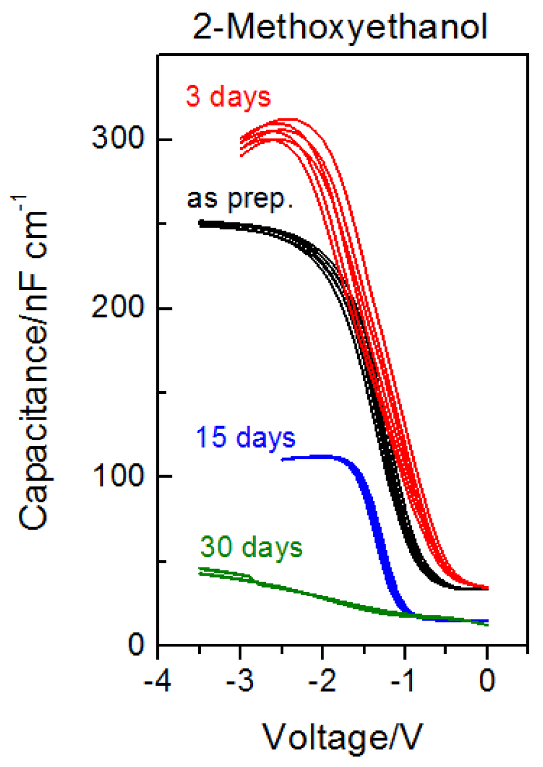
DEVICES CHARACTERIZATION

Capacitors

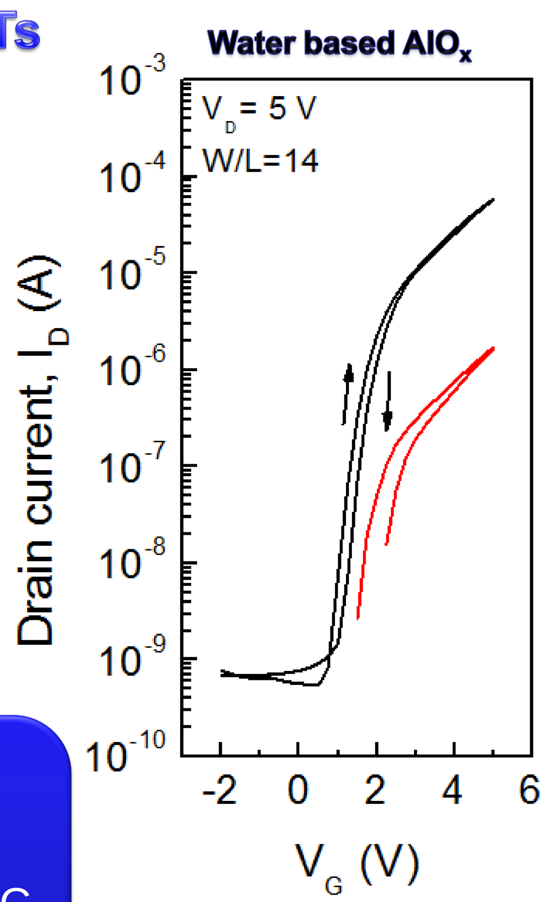


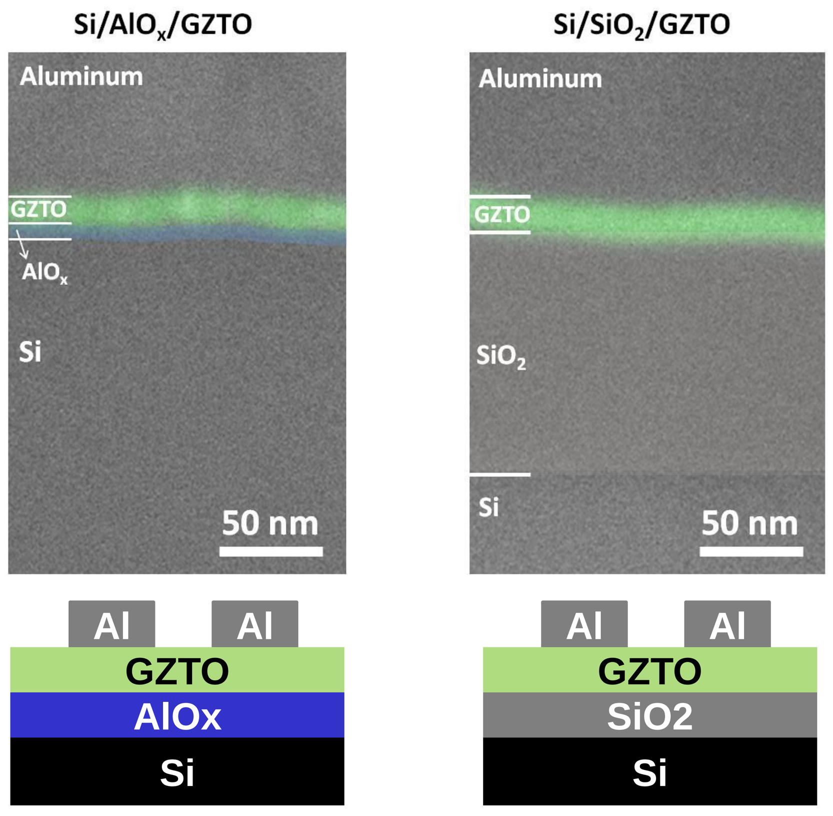
AlO_x
c=0.1 M;
10 nm layer;
T=350 °C
f=1 MHz

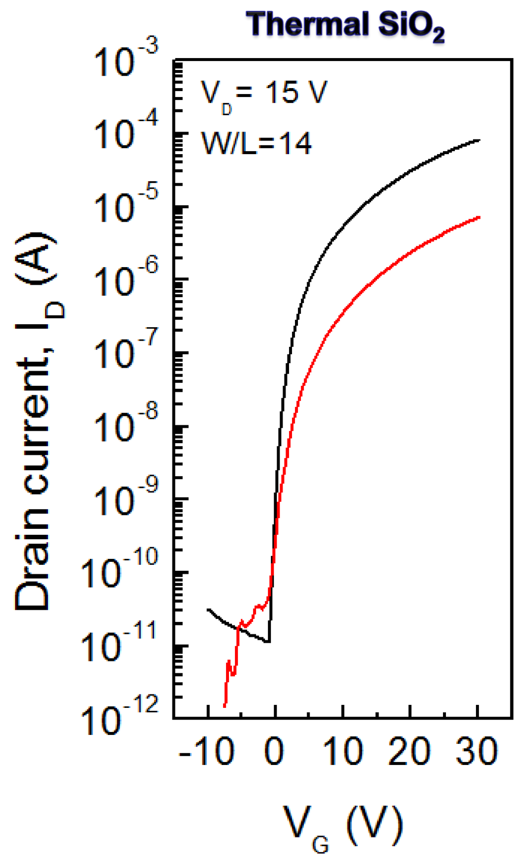




TFTs







TFTs
GZTO Zn:Sn:Ga ratio 2:1:0.1 in 2-ME @ 350ºC
AlO_x c=0.1M in H_2O @ 350ºC

Dielectric/SC	W/L	V_D (V)	V_T (V)	S (V dec⁻¹)	I_{ON}/I_{OFF}	μ_{SAT} (cm² V⁻¹ s⁻¹)
AlO_x/GZTO	14	5	0.8	0.3	8.7×10⁴	1.3
SiO_2/GZTO	14	15	0.6	0.5	7.4×10⁶	0.7

CONCLUSIONS

- Water based AlO_x thin films showed enhanced properties, high stability and an oxide formation reaction temperature approximately 25 ºC lower than 2-ME based precursors.
- 10 nm thick spin-coated AlO_x films were used together with solution processed GZTO semiconductor to fabricate TFTs with very good overall performance; V_{ON}=0.5V, V_T=0.8V, I_{ON}/I_{OFF}=8.7×10⁴, S=0.3 V/dec and μ_{SAT}=1.3 cm² V⁻¹ s⁻¹, even when compared to similar TFTs but with 100 nm thick thermally-grown SiO_2.
- Solution self-combustion synthesis is a promising method for low-cost processing of both semiconductor and dielectric oxides resulting in TFTs with a good performance.

References
[1] M.-G. Kim, et. al., Nature Materials, Vol. 10(5) (2011) 382-388.
[2] Y. S. Rim, et. al., ACS Applied Materials & Interfaces, Vol. 5(9) (2013) 3565-3571.
[3] R. Branquinho, et al. submitted to ACS Applied Materials & Interfaces.

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