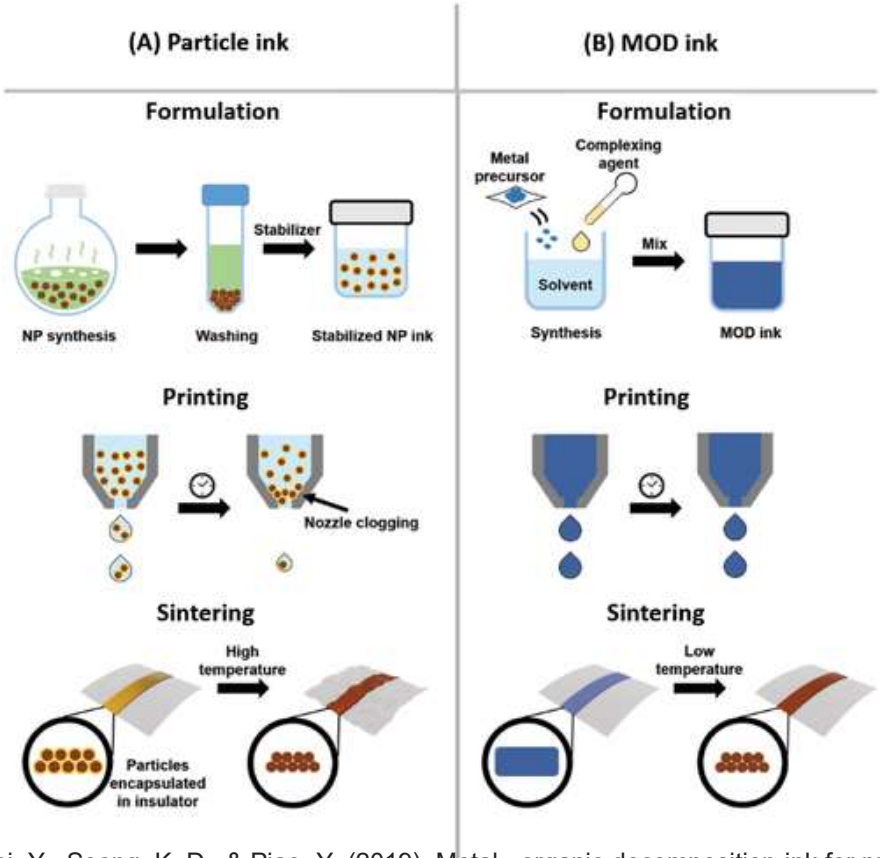
전구체/잉크 관련 연구소개

최 윤 혁 조교수/공학박사
대구가톨릭대학교 공과대학 신소재화학공학부

2021년 9월 28일

Precursor & ink process

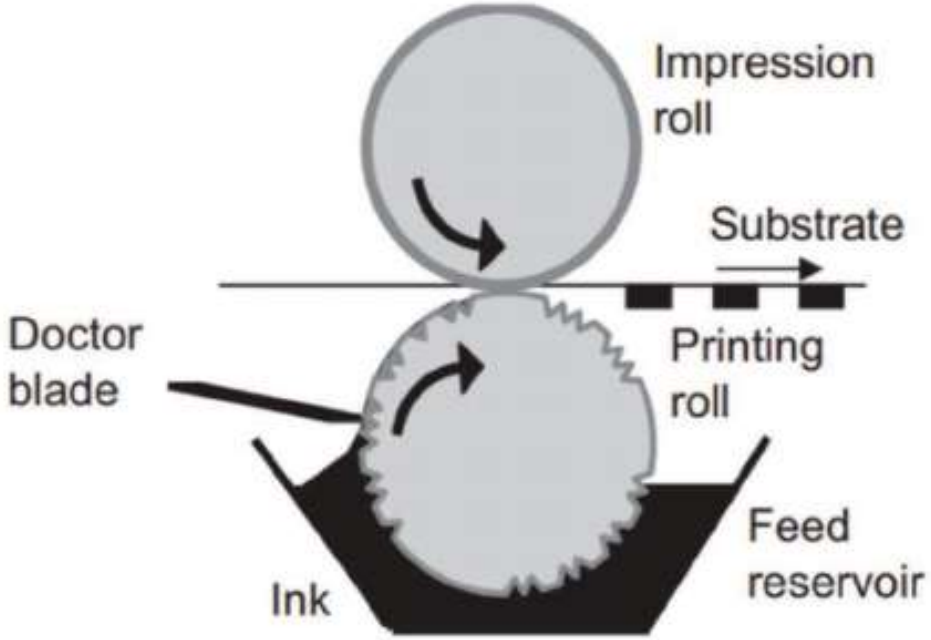


Choi, Y., Seong, K. D., & Piao, Y. (2019). Metal− organic decomposition ink for printed electronics. *Advanced Materials Interfaces*, *6*(20), 1901002.

Metal-Organic Decomposition ink

- MOD inks involve metal precursor simply dissolved in suitable solvents or organic complexing agents that serve as solvents.
- As there are no particles present, condensation and agglomeration do not occur.
- The solvent evaporation process is simple and cost-effective.

Precursor & ink process



Choi, Y., Seong, K. D., & Piao, Y. (2019). Metal− organic decomposition ink for printed electronics. *Advanced Materials Interfaces*, *6*(20), 1901002.

Gravure printing

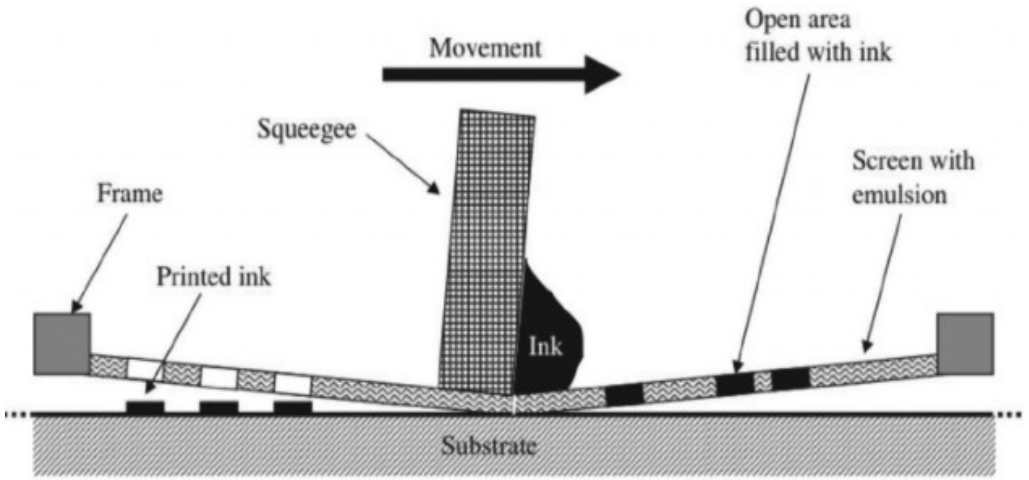
Gravure printing process

This is a commonly used cost-effective printing process suitable for high volume prints like news-paper and packaging

Executes high-resolution printing at a very high speed of up to 1 m/s

At present, gravure printing technique is used in making solar cells, polymer field-effect transistors, and OLEDs

Precursor & ink process



Choi, Y., Seong, K. D., & Piao, Y. (2019). Metal− organic decomposition ink for printed electronics. *Advanced Materials Interfaces*, *6*(20), 1901002.

screen printing

Screen printing process

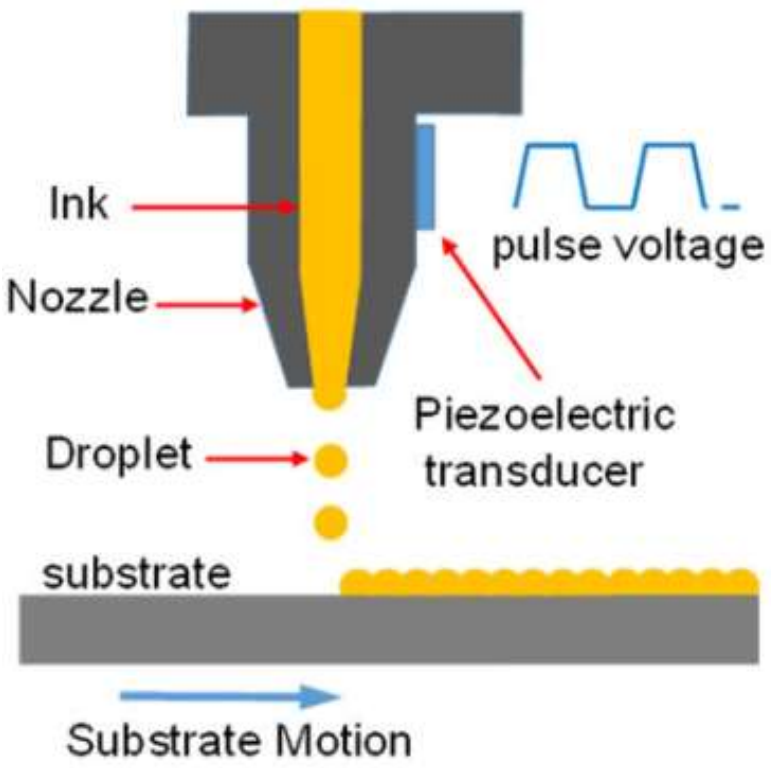
This is another simple and cost-effective conventional printing technique

This is method is highly compatible with various organic inks and operates under ambient pressure

The downside of this method is a relatively low resolution(>75μm) when employed for producing large feature sizes

Screen printing is extensively used in industry for conducting various tasks, form simple tasks like test or etch resists printing to complex tasks such ac conductors for flexible electronics

Precursor & ink process



Modern key technology for various industrial processes

It offers accurate and rapid deposition of ink in various composition in a large scale at low cost, and suggests possibility of very small amount deposition

It is also a noncontact and mask-free method that minimizes substrate contamination

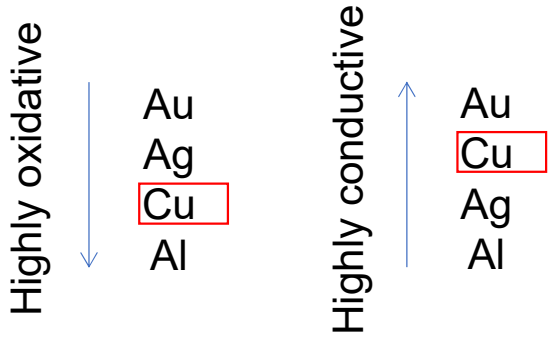
This method allows automated fabrication of selective patterning

Choi, Y., Seong, K. D., & Piao, Y. (2019). Metal− organic decomposition ink for printed electronics. *Advanced Materials Interfaces*, *6*(20), 1901002.

Ink jet printing

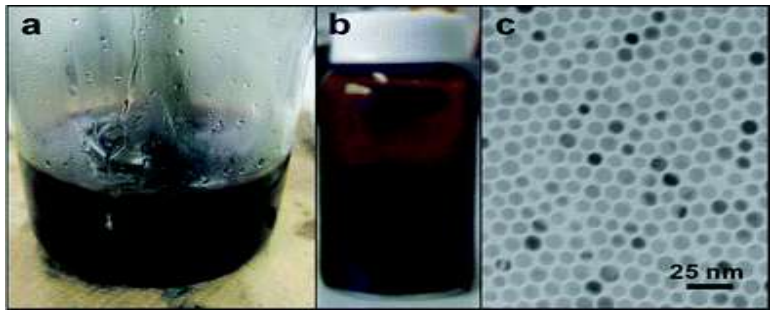
♦ Formulation of Cu(II) Complex Inks for Printed Cu Metallization

- Materials



※ Cu → abundant, nontoxic elements on earth
Thus, low-cost, environment-friendly devices can be achieved.

- Cu nanoparticle-based ink



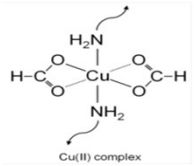
J. Mater. Chem., 2011, 21, 37062-37069.

Ink formulation ➡ **$Cu(HCOO)_2 \cdot 4H_2O$ + Hexylamine + Ethyl cellulose/NMP**

knife-over-edge/screen/slot-die/offset printing

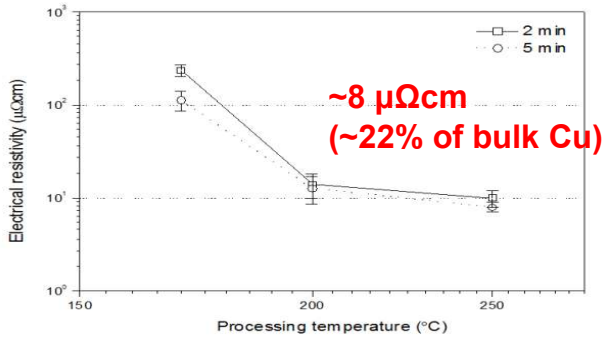
23.58 Pa·s; 11.75 Pa·s ; 5.79 Pa·s

Formation of $Cu(HCOO)_2$ – hexylamine complex

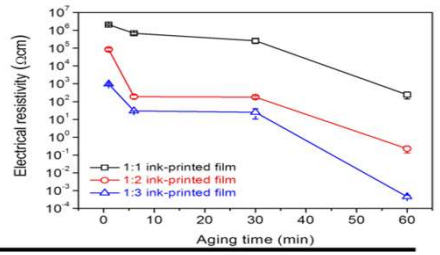


Highly adhesive, conductive Cu films

1:2 ink

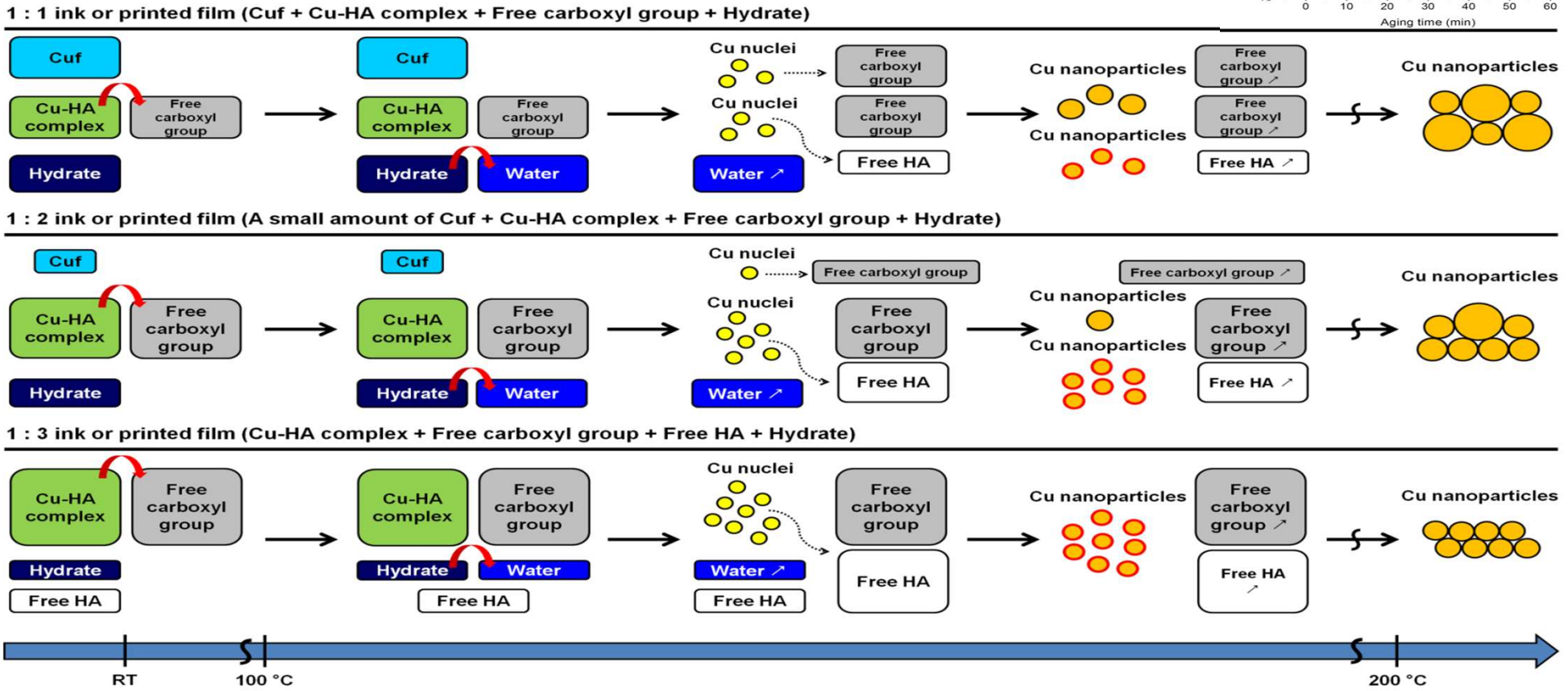


♦ Nucleation and Growth Behavior of Cu NPs by *in-situ* FT-IR and Thermal Analysis



*** Phase evolution and densification of Cu(II) complex ink printed films**

: Dual effects of HA → Reducing and capping agents

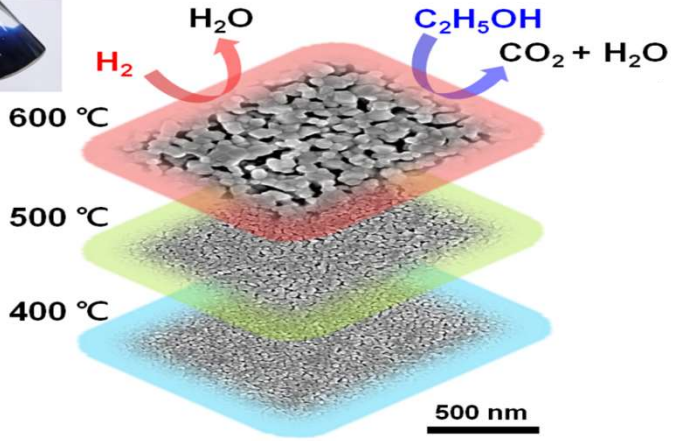


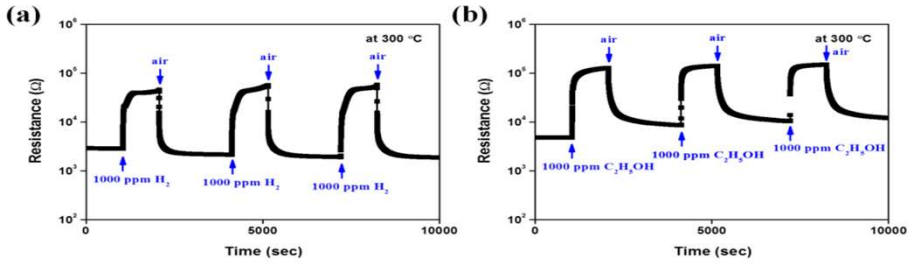
The design rules for the formulation of the solution-type inks to control the microstructure of printed metallization

♦ Extended applications in gas sensors and photoelectrodes: CuO nanostructures

(1) Direct printing synthesis:
Mesoporous CuO thin films

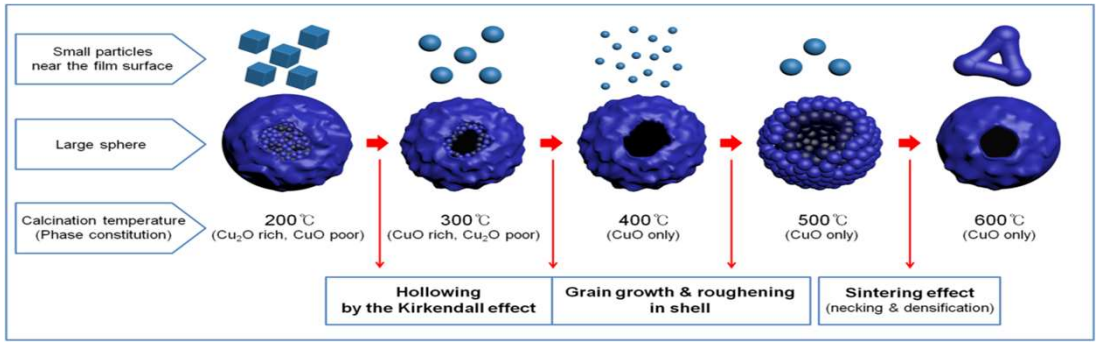
*** 1:4 ink (High amine concentration)**
→ Mesoporous/porous CuO thin film

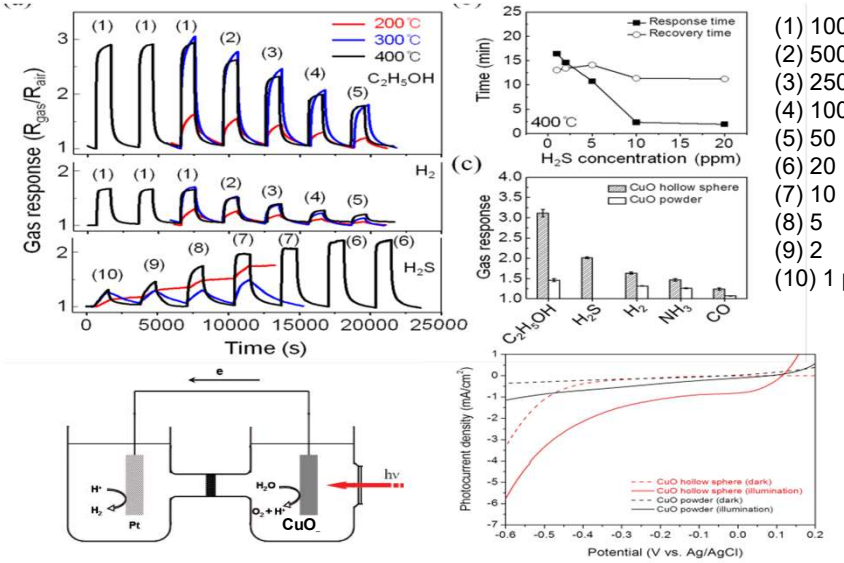




(2) Direct printing synthesis: Self-organized copper oxide hollow spheres on a substrate

*** 1:1 ink (Low amine concentration)**
→ Self-organized copper oxide hollow spheres
→ Nanoscale Kirkendall effect ($D_{Cu} > D_O$)





(1) 1000
(2) 500
(3) 250
(4) 100
(5) 50
(6) 20
(7) 10
(8) 5
(9) 2
(10) 1 ppm

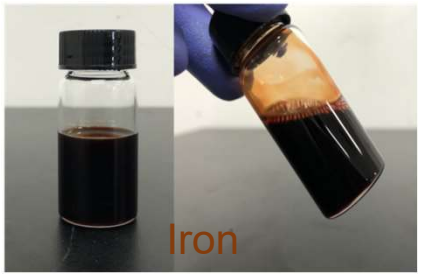
Precursor & ink process

Ceramics and Materials Chemistry Lab.

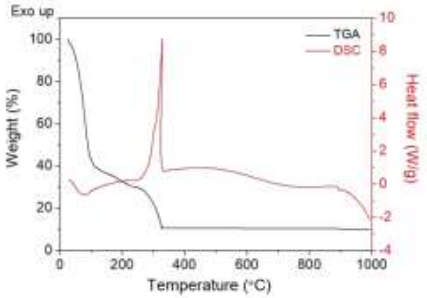
Metal-Organic Decomposition ink precursors

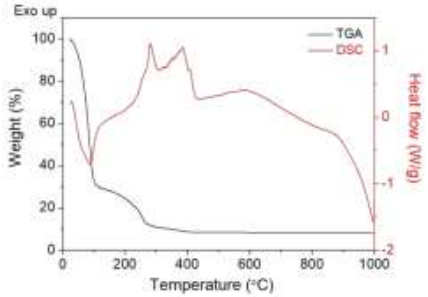
(a)

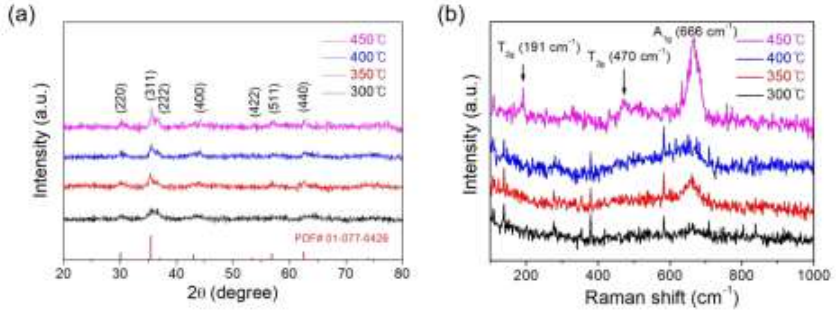
(b)

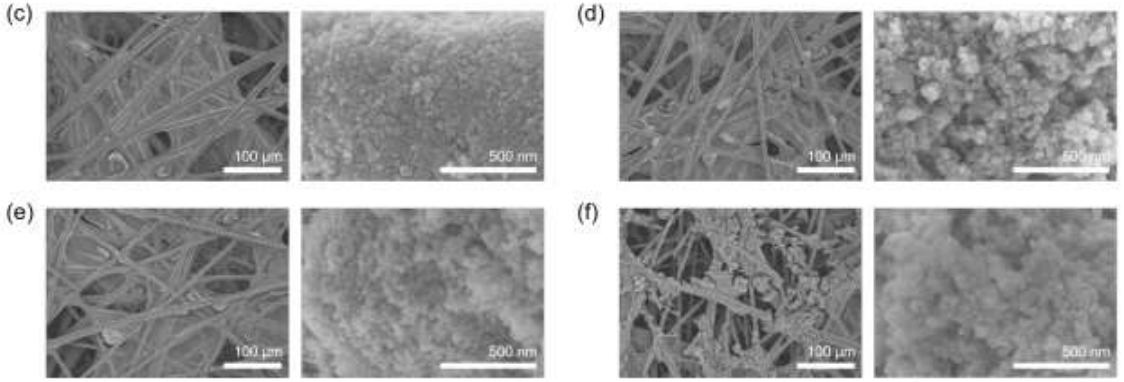


Ink formulation ➡ $Co(C_7H_{15}COO)_2$ + Xylene
$Fe(C_7H_{15}COO)_3$ + Xylene









$CoFe_2O_4$ film & nanoparticles

Kim, K. H., & Choi, Y. H. (2021). Highly efficient CoFe2O4 electrocatalysts prepared facilely by metal-organic decomposition process for the oxygen evolution reaction. *Electrochimica Acta*, 139195.

Precursor & ink process

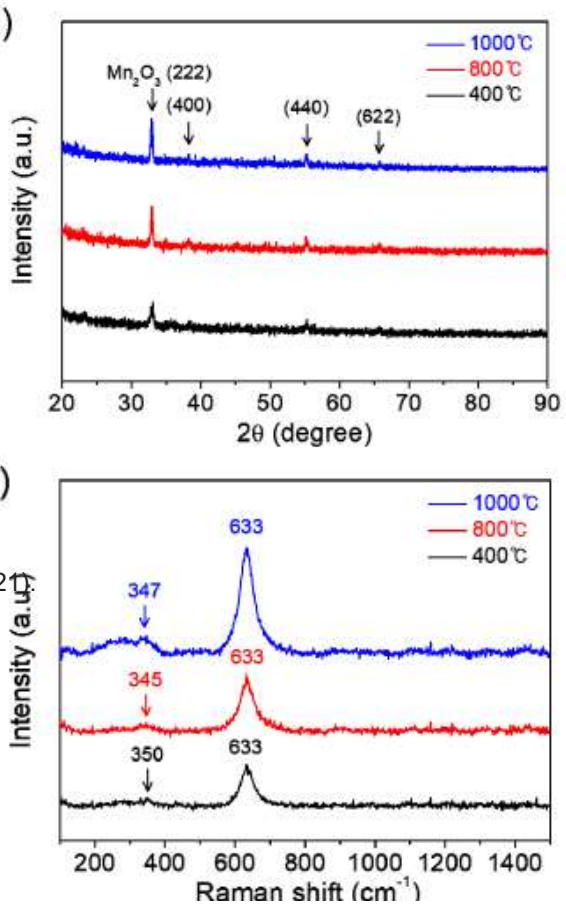
Ceramics and Materials Chemistry Lab.

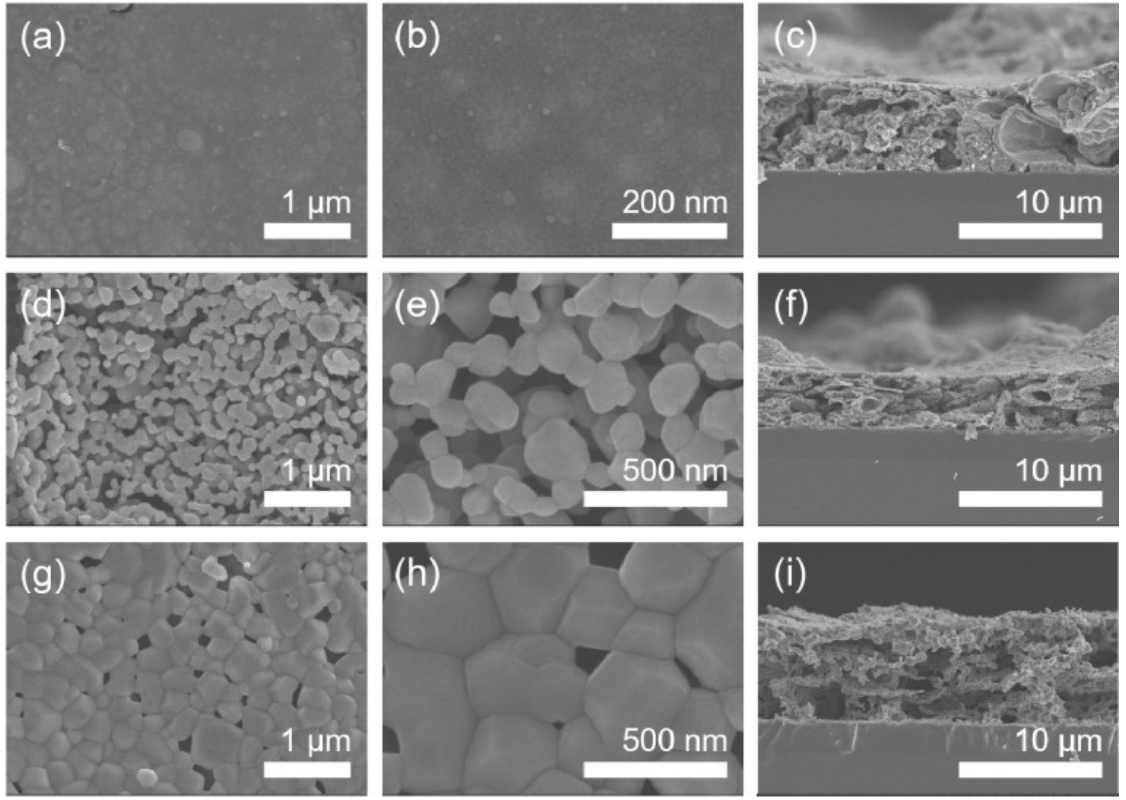
Metal-Organic Decomposition ink precursors

Manganese 2-ethylhexanoate solution

Ink formulation

$Mn(OOCCH(C_2H_5)C_4H_9)_2$ + Xylene





Mn_2O_3 films

Kim, K. H., Lee, D. K., & Choi, Y. H. (2021). Fabrication of Single-Phase Manganese Oxide Films by Metal-Organic Decomposition. *Materials*, *14*(9), 2338.

Precursor & ink process

Ceramics and Materials Chemistry Lab.

- Synthesis of Chemical Metal Precursors for MOD process
- Pb, Ca, Ti, Co, Fe, Zn, Mn, Cu etc.
- Mix the solution to make a metal compound.