

# Multistep inorganic synthesis to generate emergent functions

Keywords: Logic of chemical synthesis, Atomically designed materials, Complex system

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## Background

- Biological systems emerge high-level functions via positioning functional molecules.
- Multistep organic synthesis can control 3-dimensional position of functional molecules.
- Organic materials can mimic the emergent functions but cannot resist heat in general.

## Aim

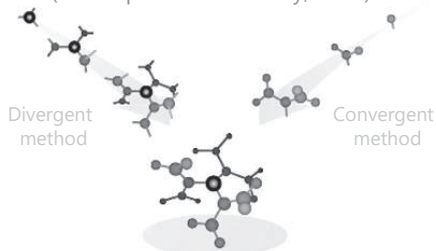
- To open the door to emergent inorganic materials mimicking biological systems.
- To apply the logic of chemical synthesis to inorganic synthesis through integrating a solution process and a vacuum process.
- To produce oxide-based durable emergent materials with a wide choice of metal ions.

## Advanced Research Topics

Target in the next 10 years

### ~ Multistep organic synthesis ~

(Nobel prize in chemistry, 1990)

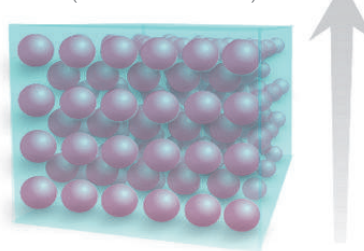


Logic of  
chemical  
synthesis

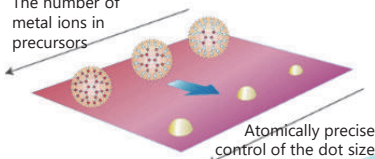
Apply

### ~ Multistep inorganic synthesis ~

(Aim for this work)



The number of  
metal ions in  
precursors



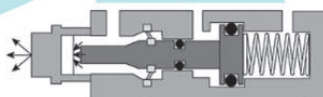
### Solution process

atomically precise dot deposition

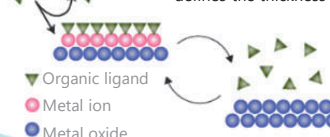
10 years' accumulation

### New spray technique

for solution process in a vacuum



The cycle number atomically  
defines the thickness



### Vacuum process

atomic layer deposition

## Publications

- Satoh *et al.* Nature Nanotechnology 3, 106–111 (2008)
- Satoh *et al.* Scientific Report 3, 1959 (2013).
- Satoh, Interdisciplinary Journal of Chemistry 1, 52–57 (2017)

## Summary

- We can control dot size with atomic precision.
- We can cyclically deposit atomic layers.
- New spray technique has been developed to integrate the solution process and the vacuum process in a vacuum chamber.

## Research outcome

- See the Aim.