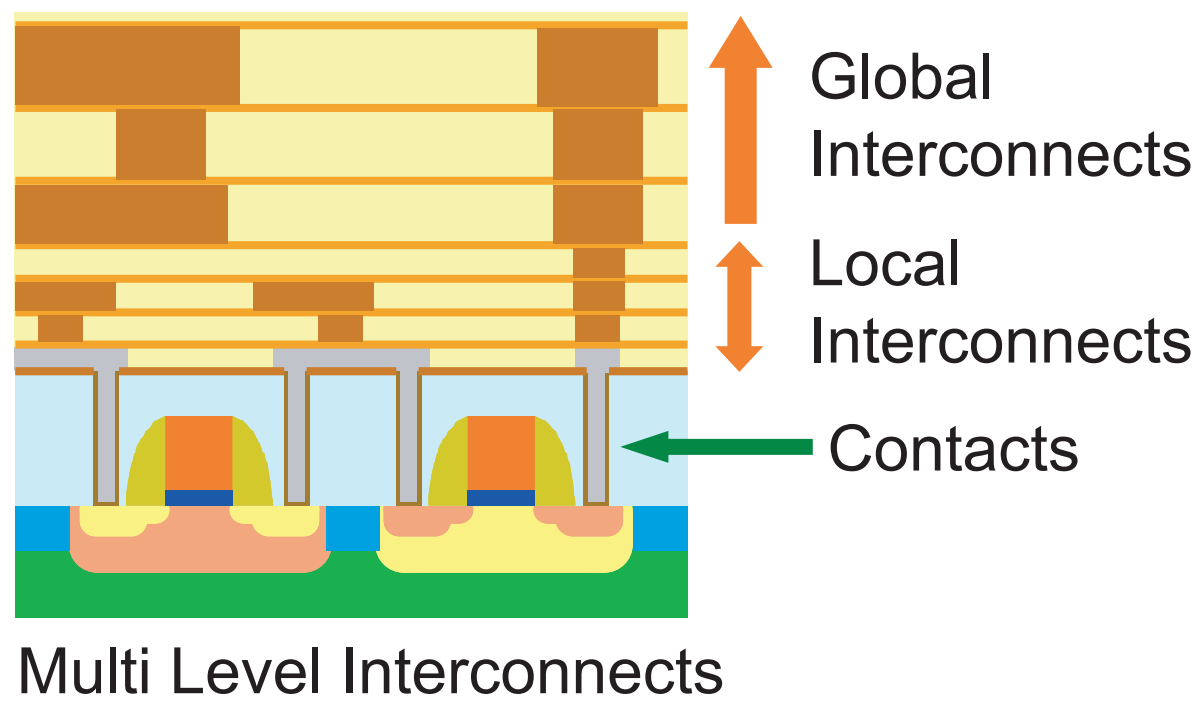


# AI-CVD Technology for Multi Level Interconnect of Si ULSI

Tokyo Institute Technology, Precision and Intelligence Laboratory, Masu Lab.

Manabu Sakamoto, Kazuya Masu

## Background and Purpose



### Background

ULSI shrinks every year according to a miniaturization scaling.

Year	2004	2005	2006
DRAM 1/2 Pitch (nm)	90	80	70
MPU/ASIC 1/2 Pitch (nm)	90	80	70
Contact A/R stacked capacitor	15	15	16

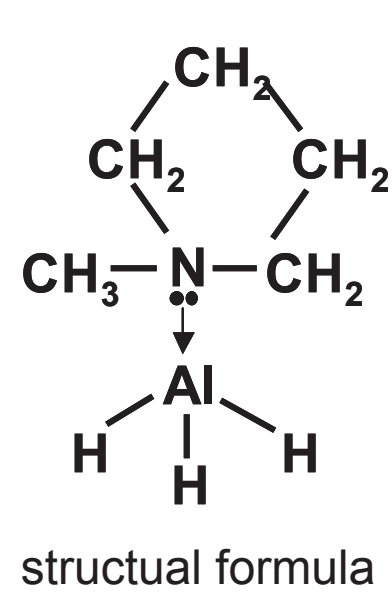
### Purpose

Filling Al into large-aspect-ratio contact holes with AI-CVD technology

### The features of AI-CVD

- Against DD-Cu
  - No requirement of metal CMP
  - Low cost
  - High Yield
- Against W-plug
  - Low resistivity
  - No requirement of metal CMP
  - High Yield

## AI-CVD Precursor



MPA  
 Chemical name: Methylpyrrolidine:Alane  
 Chemical formula:  $\text{AlH}_3:\text{N}(\text{CH}_3)(\text{CH}_2)_4$   
 Molecular weight: 115.16  
 Color and Form: Clear colorless liquid  
 Vapor pressure: 1.6Torr @46°C

Precursor	TMA	TIBA	DMAH	DMEAA	MPA
Deposition Temp.	230°C	200°C	180-270°C	130-180°C	95-180°C
Selective Dep.	Possible	Possible	Possible	Difficult	Possible
Carbon Incorporation	High	Low	Low	Low	Low
Chemical Stability	Yes	Yes	Yes	No	Yes
Pyrophoric	High	High	High	High	Low

### Features of MPA

- MPA has alane ( $\text{AlH}_3$ ). There is no Al-C bond. → Carbon incorporation is low.
- Al-N coordinate bond strength **MPA > DMEAA** → Chemical stability

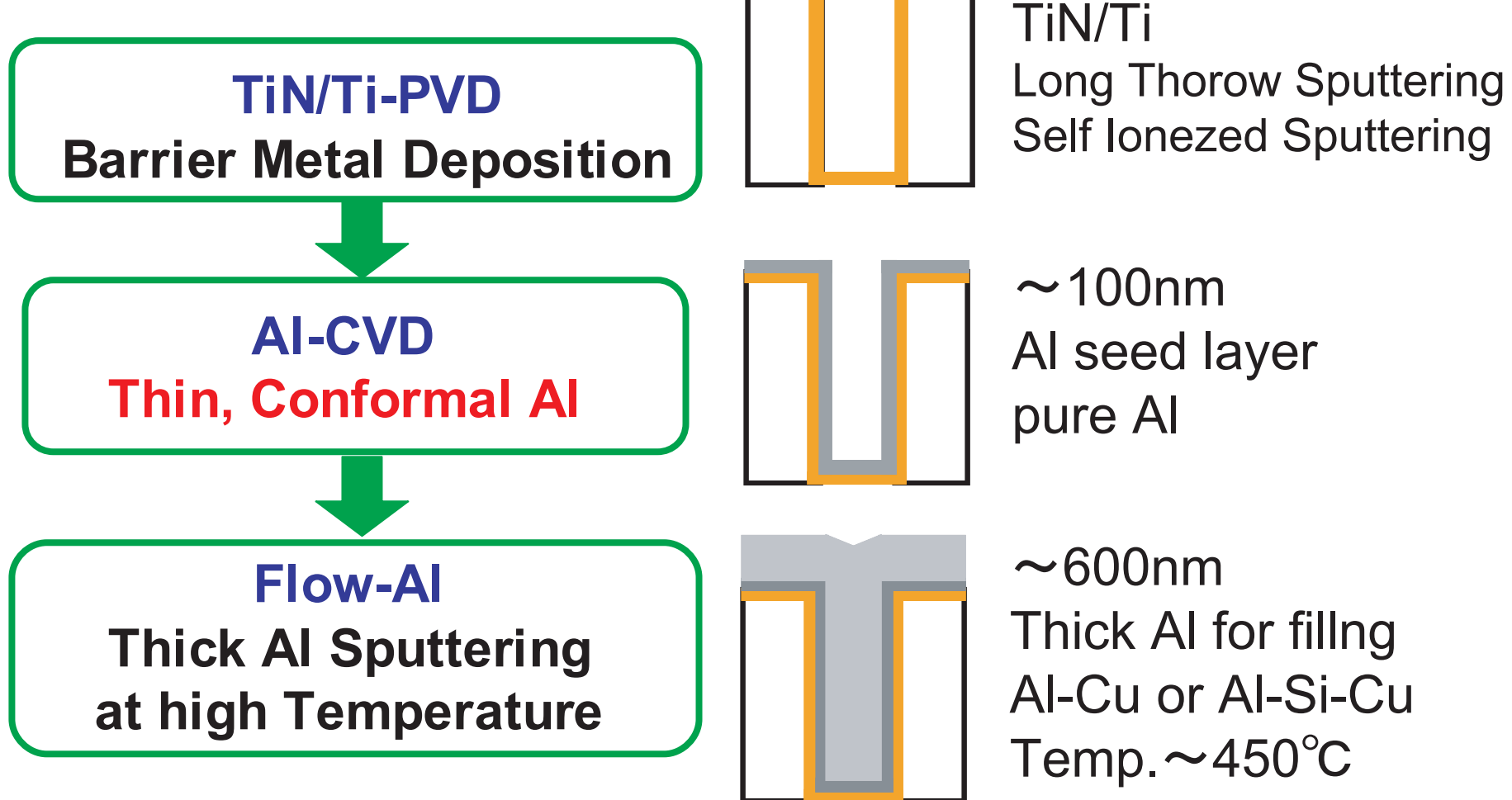
## Contact Hole Filling

### Process sequence

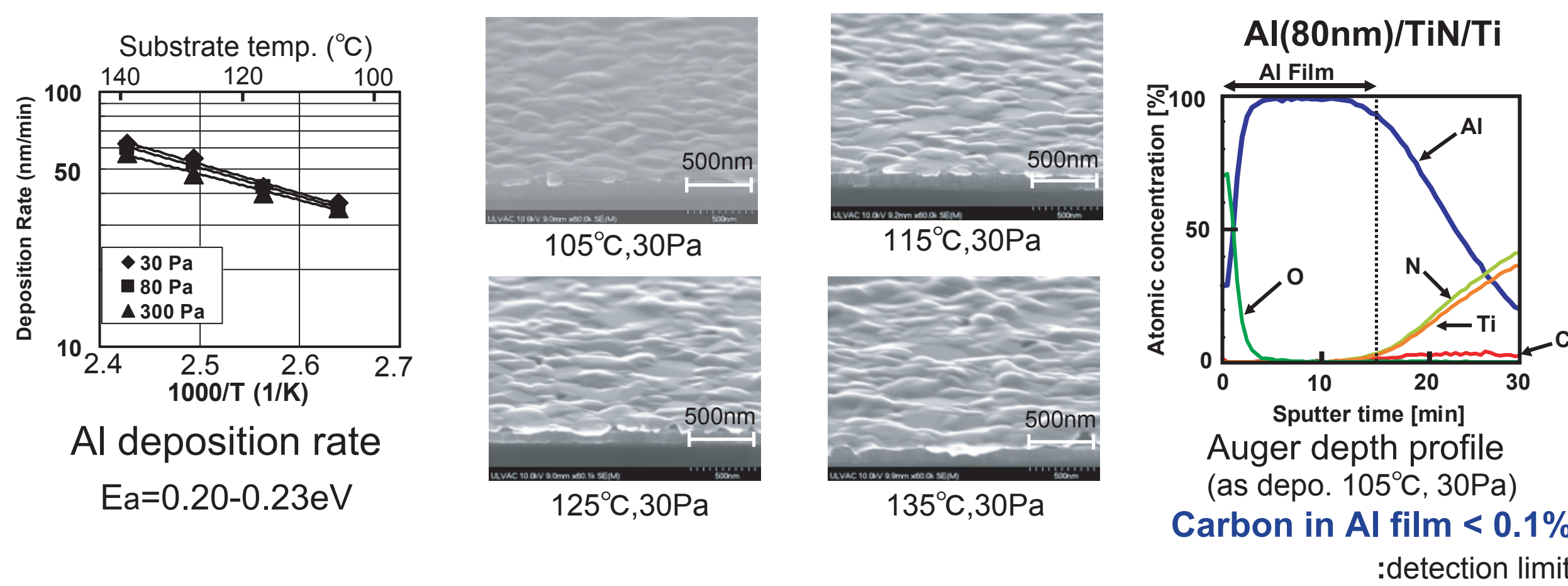
Joint Research  
ULVAC Inc.  
Institute for Semiconductor Technologies



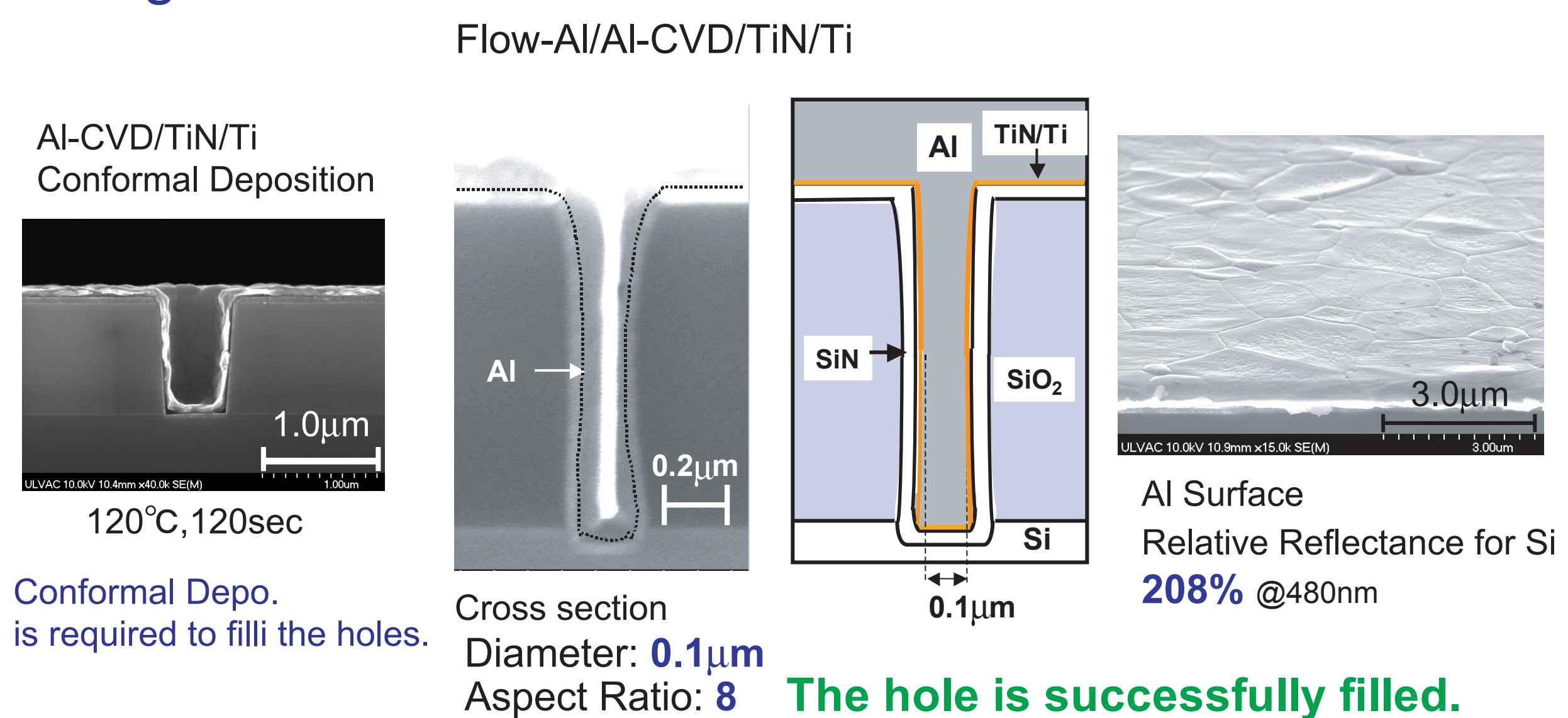
The Cluster apparatus with 8inch CVD, PVD Chambers



### AI-CVD characteristic



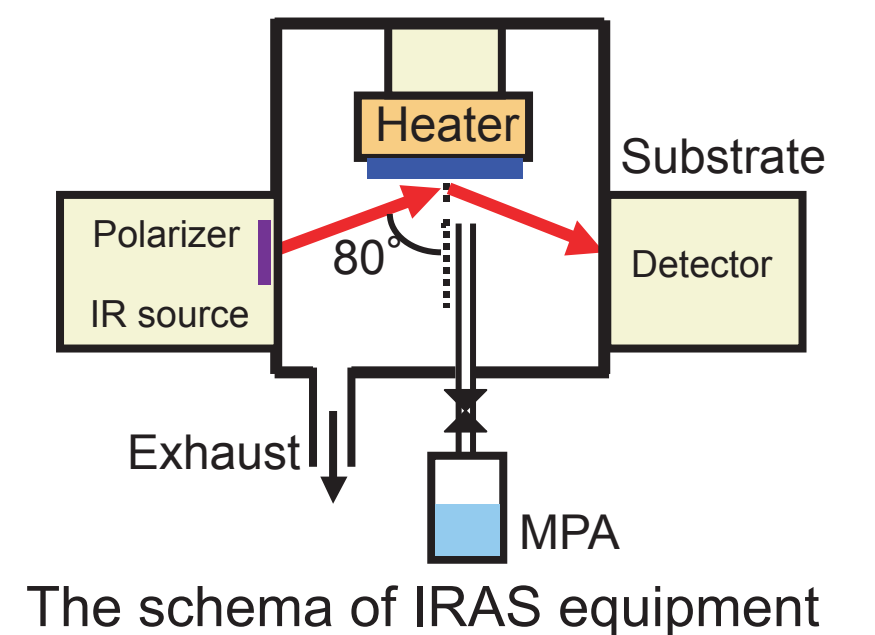
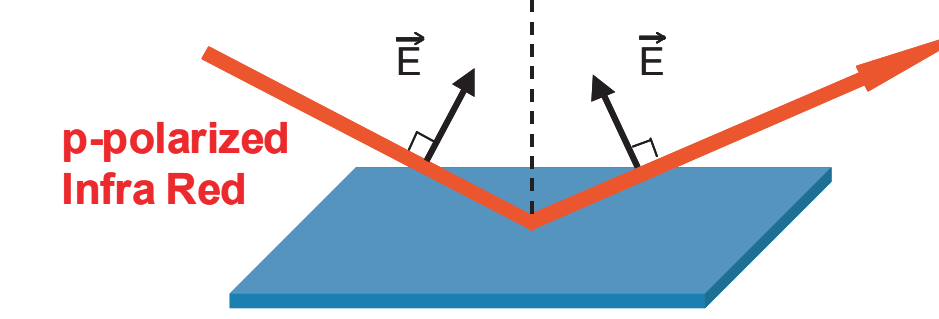
### Filling characteristic



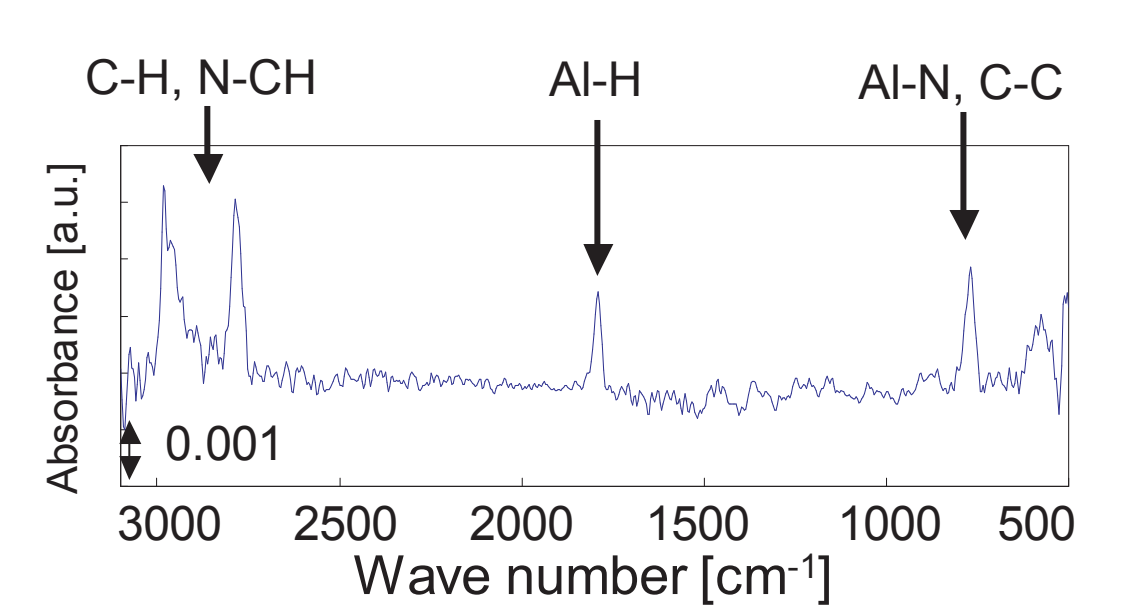
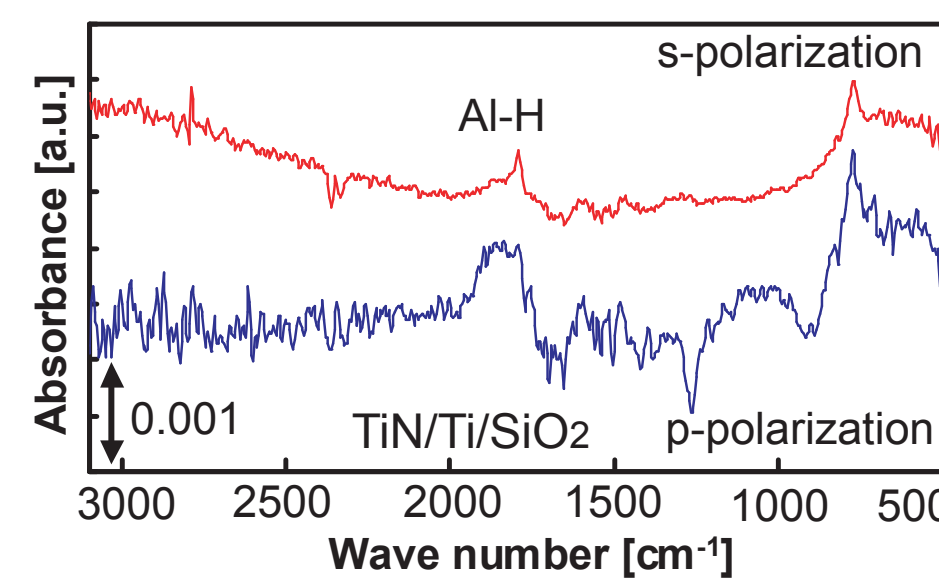
## Surface Reaction Analysis

### IRAS analysis

IRAS: Infrared Reflection Adsorption Spectroscopy

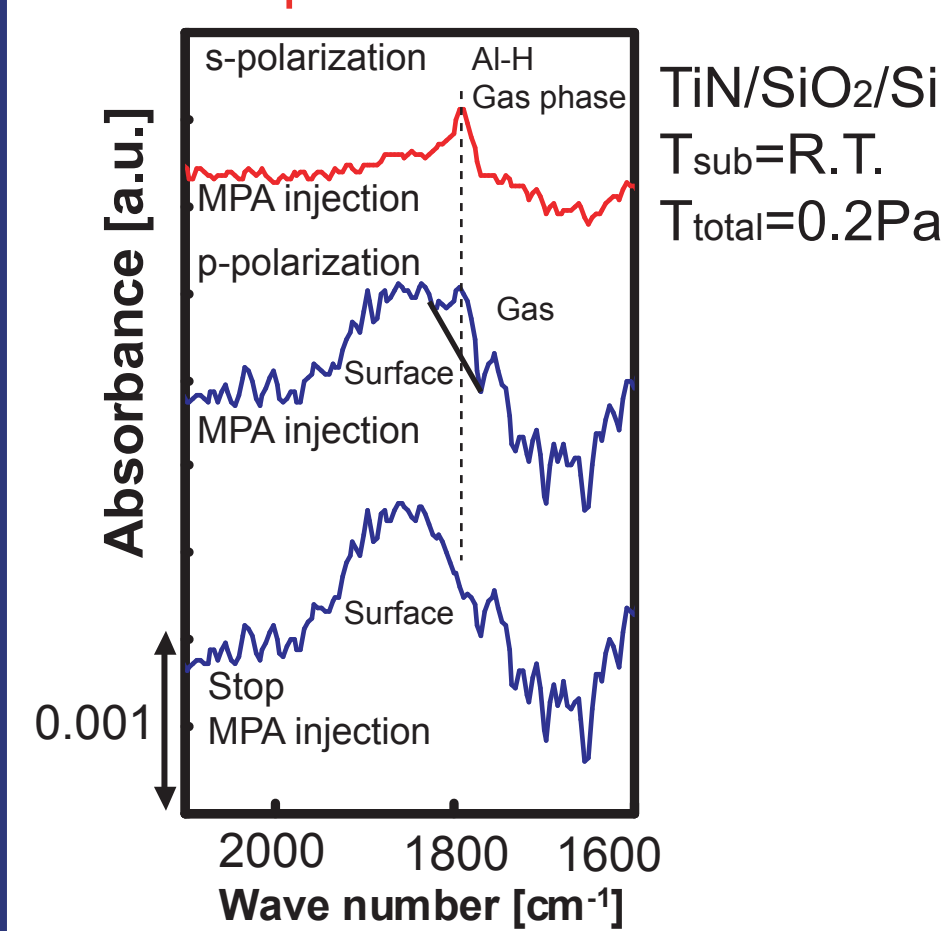


### Spectra

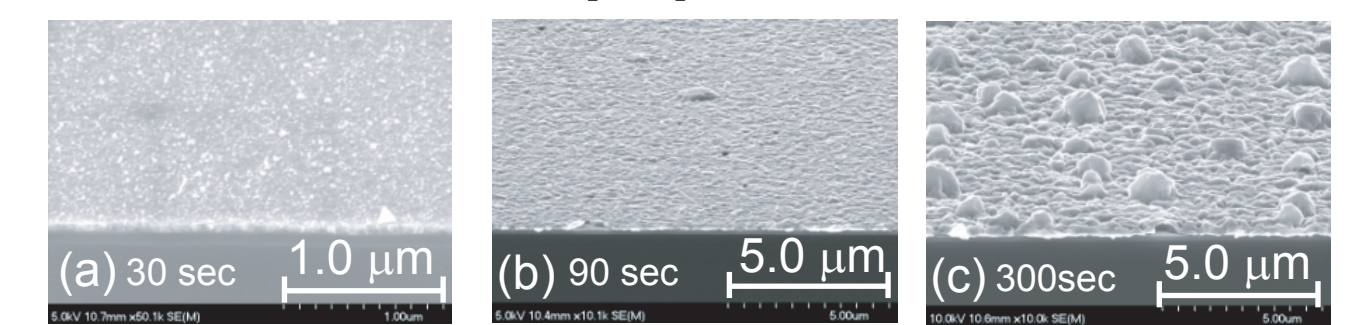
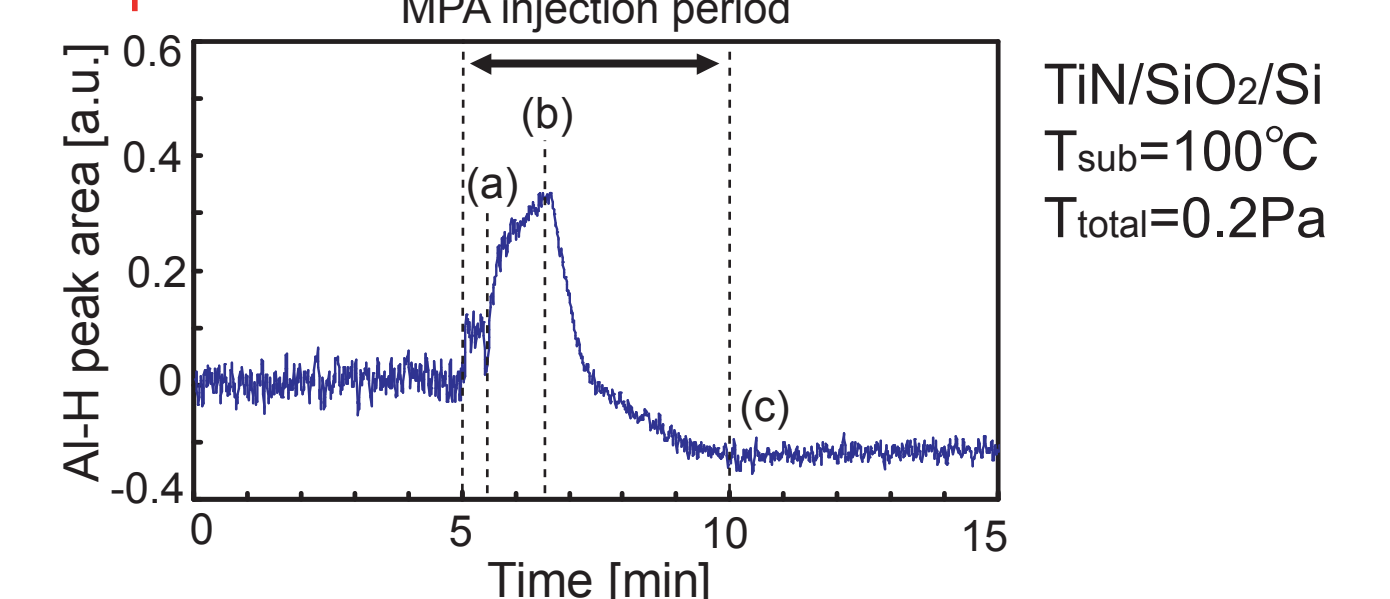


### AI-H peak

Adsorption at R.T.



Deposition

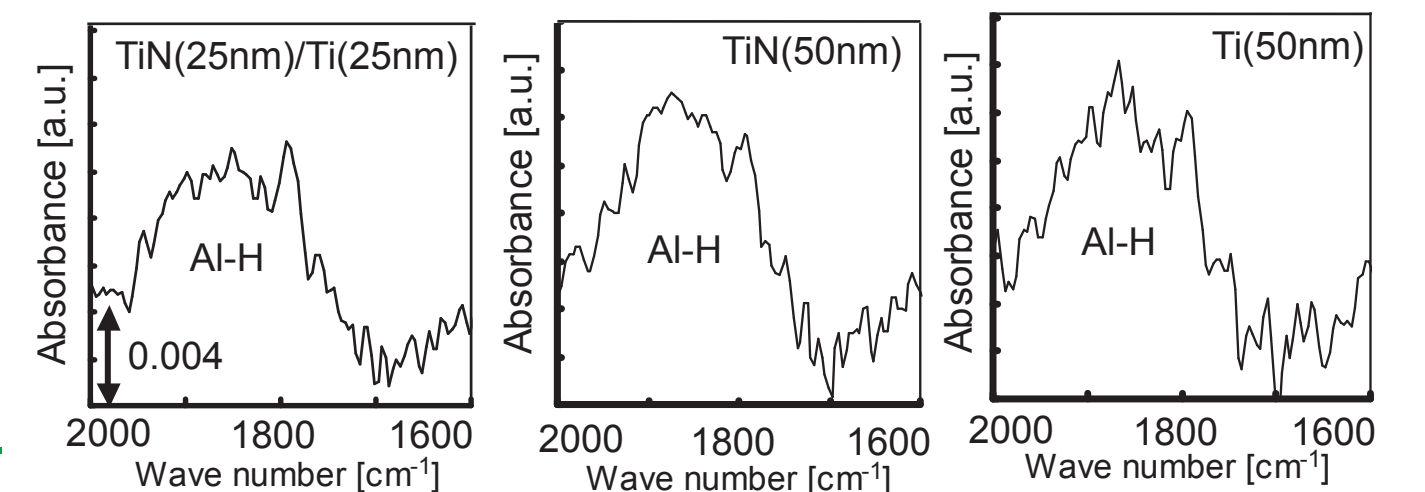


The adsorbed Al-H was observed.

The surface morphology changed.

Adsorption on underlayers at R.T.  
 $T_{\text{sub}} = \text{R.T.}, P_{\text{total}} = 0.2 \text{ Pa}$

The amount of Al-H was different.



Acknowledgement

We thank Dr. Masakazu Sugiyama of The University of Tokyo for his advice on IRAS analysis.

## Conclusions and Future work

The contact holes of diameter 0.13µm with an aspect ratio of 8 can be successfully filled by the Flow-AI/AI-CVD technology.

The adsorbed Al-H on substrate surface is observed, and the amount of Al-H is different depending on the underlayer.

The Al-H peak change during deposition.

Analyze surface reaction by IRAS  
 Investigate into deposition mechanism  
 Obtain conformal Al film

Improvement of Filling capability