### Surface Chemistry of Copper Precursors in Connection with Atomic Layer Deposition (ALD) Processes

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Surface Chemistry of Copper Precursors in Connection with Atomic Layer Deposition (ALD) Processes

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ALD International Conference
Boston, June 28, 2011
ALD: Separate chemistry into two self-limiting and complementary reactions for more control.

Copper Acetamidinate: Promising ALD precursor

Cu Amidinate Thermal Chemistry
Stepwise Decomposition, TPD on Ni(110)

Cu Amidinate Thermal Chemistry
Dimer Dissociation upon Adsorption

Cu Amidinate Thermal Chemistry
First C–N Bond Dissociation, T ~ 200 K

Cu Amidinate Thermal Chemistry

N-sec-Butylacetamidine Formation

Cu Amidinate Thermal Chemistry

Cu Reduction

Copper reduction occurs as N-sec-butylacetamide desorbs

Cu Amidinate Thermal Chemistry
High Temperature Conversion, C 1s and N 1s XPS


Francisco Zaera
Department of Chemistry
University of California, Riverside
Cu Amidinate Thermal Chemistry
Butene Formation and Further Dehydrogenation

Cu Amidinate Thermal Chemistry
Proposed Mechanism

Several intermediates form vs. T
Some may desorb molecularly, but by ~ 480 K dehydrogenation is irreversible

$N$-sec butylacetamidine

Dissociative adsorption

$\text{N(110)}$

$\text{Ni(110)}$

$\text{Ni(110)}$

Copper reduction $\text{Cu(I)} \rightarrow \text{Cu(0)}$


Francisco Zaera
Department of Chemistry
University of California, Riverside
Cu Amidinate Uptake
Effect of Temperature and Hydrogen

Cu-Amidinate/Ni(110)
Uptake at Different Temperatures

150L H₂ Predose

Fast and continuous uptake above 460 K. Possible CVD. Deposition of impurities.

Butene desorption
Extensive dehydrogenation

Uptake past monolayer above 400 K

Acetonitrile formation

N-sec-butylacetamidine desorption

No uptake below 300 K

No appreciable changes seen with hydrogen surface presaturation

Cu Amidinate Uptake
Growth Rate, LEIS

Cu Amidinate Thermal Chemistry
Proposed Mechanism

Several intermediates form vs. T
Some may desorb molecularly, but
by ~ 480 K dehydrogenation is irreversible

N-sec butylacetamidine

Dissociative adsorption

Copper reduction Cu(I) → Cu(0)