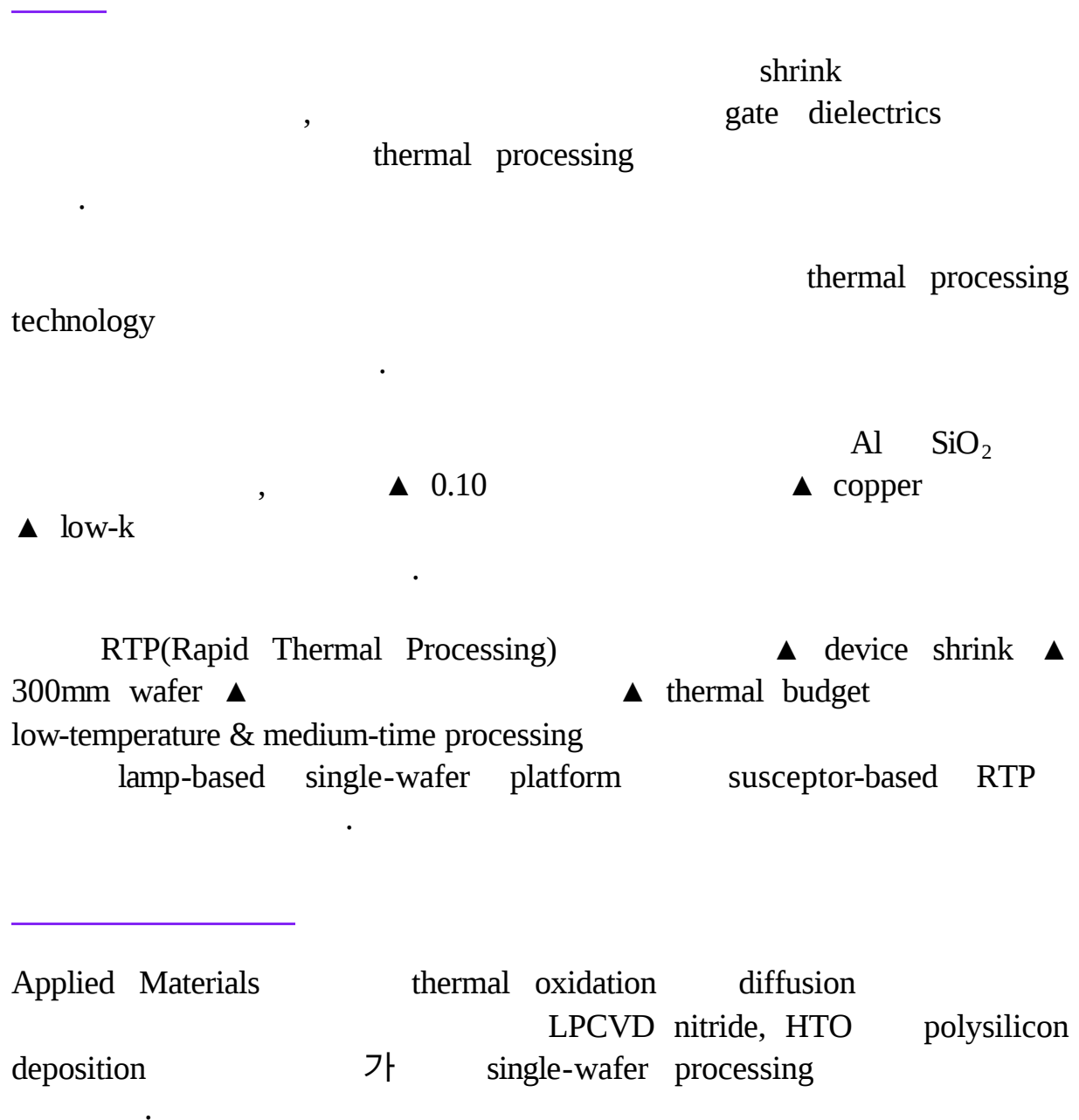
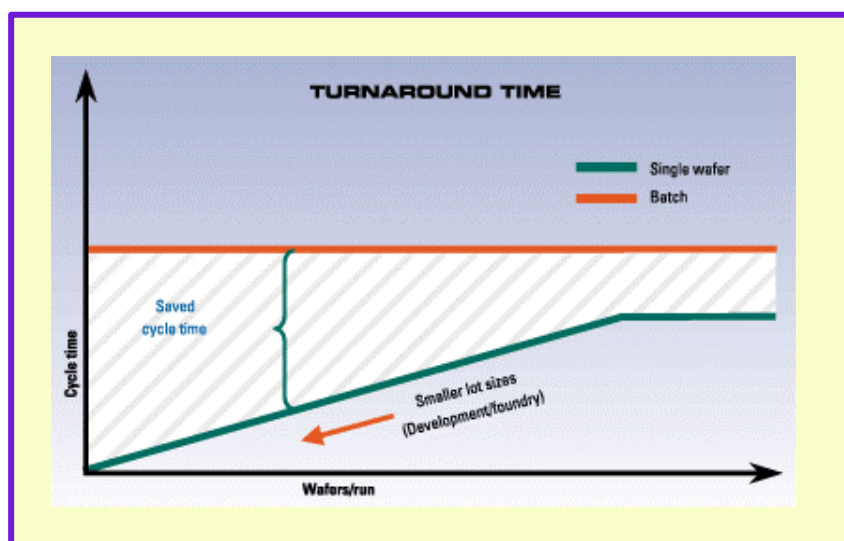


Thermal Processing



RTP ramp-up ramp-down rate
 가 가 ultrashallow junction
 depth thermal budget .
 0.13 sidewall spacer furnace low-
 temperature nitride (uniformity) 가 .
 300mm batch
 single-wafer processing ,
 .
 0.13 200mm 가 가
 . 300mm single-wafer 가
 , process cycle-time
 .
 process cycle-time batch furnace cycle-time
 CPW(cost per wafer)가
 single-wafer processing 가 .



1. single-wafer processing fab 가
 (Source: Applied Materials)

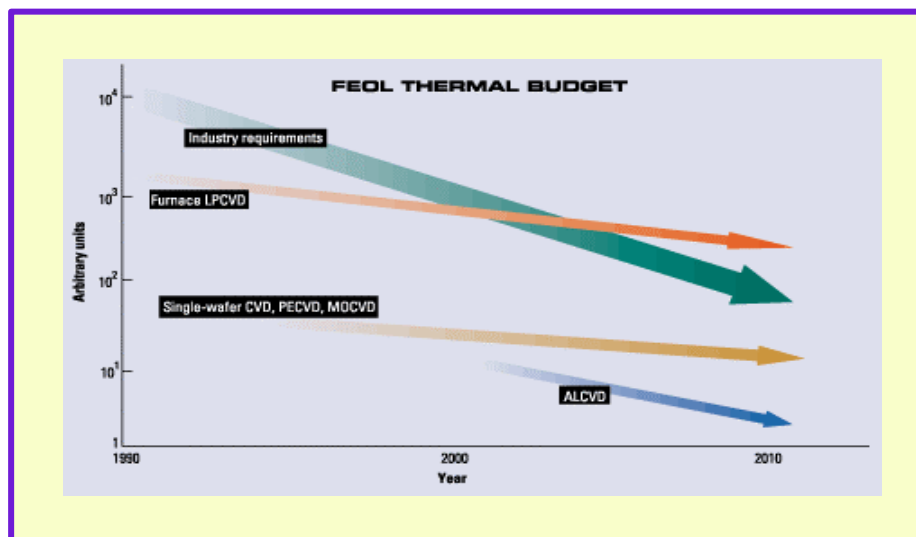
single-wafer processing

starting cassette 1

fab 가

CoO

spacer processing system ultras hallow junction gate scaling
 700°C furnace 700°C 300mm single-wafer
 low-temperature processing
 thermal budget <680°C



2. thermal budget (Source: ASM).

ALD

ALD processing throughput thick film CVD

/ channel mobility gate dielectric
 0.10 SiO₂

throughput batch single-wafer 가
deposition time . ▲
heating / cooling overhead ▲ wafer handling ▲ pressure balancing
가 . ramp-up ramp-
down rate low-/high-k 가 가 ,
가 .

Lamp vs. Hot Wall

300mm single-wafer processing
▲ processing time ▲ high temperature
processing / ▲ wafer uniformity ▲
robust
가 .

300mm hot-wall RTP lamp-based
system 가 . lamp-based system
lamp bank thermal balancing
scale-up 가 가
가 . hot-wall system thermal balancing
thermal uniformity .

thermal processing ▲ CoO ▲ (H₂, O₂ carrier gas
) ▲ thermal budget large batch, small batch single-wafer
processing . large-batch type single-wafer type
가 , process cycle-time
가 fab
single-wafer processing .

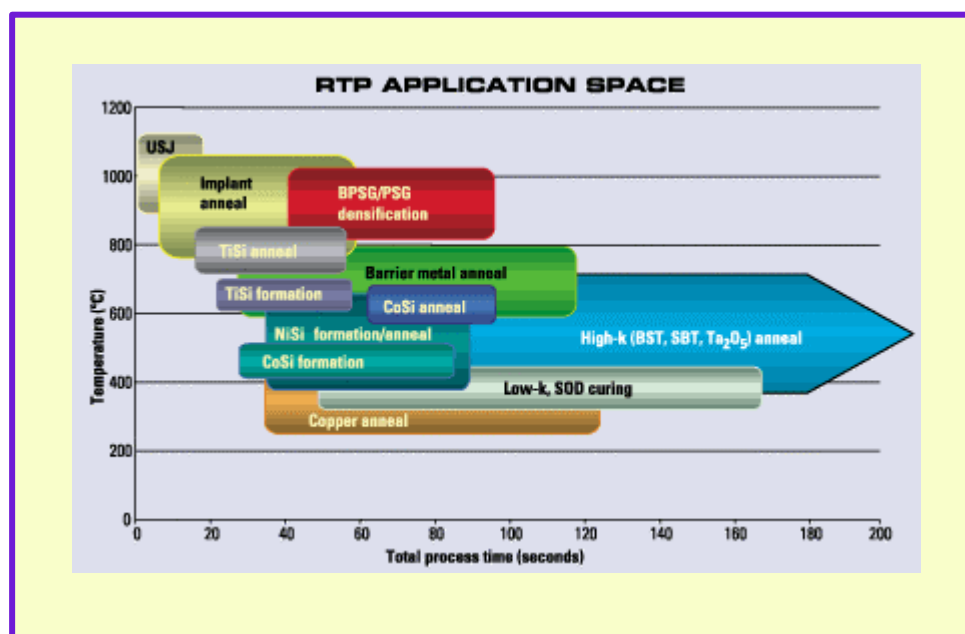
0.13 film uniformity
temperature uniformity가 film uniformity control
composition batch hot wall reactor
particle lifetime 가 .

SiO₂ gate가 <15 Å 가 .

Dielectric & Thermal Budget

IBM 1998 copper
thermal budget copper 가 BEOL processing
(max. ~400°C) . IBM SiLK spin-on dielectric
425°C 450°C

BEOL 가 가
thermal budget . 0.13
gate strap 8



3. BPSG reflow silicide applications STI liner formation shallow junctions anneal

(Source: Mattson Technology)

400°C

가

STI liner formation

steam oxidation

H₂

steam

Annealing

annealing

copper

annealing

(350°C~400°C)

self-annealing

recrystallization

,

low-temperature annealing (~300°C)

thermal processing

fab

single-wafer hot-plate type annealing process

RTP

batch

furnace가

.

annealing

가

1

ECD

annealing

,

self-annealing process

recrystallization

.

annealing

grain size

electromigration resistance

.

recrystallization

self-annealing

dopant

copper

(mobility)

CMP rate

가

defect

.

New Fabs & Single-wafer

CoO fab vertical furnace processing
fab vertical furnace
single-wafer platform 0.13
0.10 가

SVG 'Xcelerate' single-wafer platform vertical furnace
, hot walls batch
transfer, DCS-based nitride 가 . lamp-based system
film deposition DCS-based
nitride 가 .

uniformity가 SVG
large batch furnace capacitor dielectric DCS-based thin nitride
3% 3d 0.13
single-wafer dichlor process batch system
1/2~2/3 .

thermal processing APCVD-type process .
locos oxide isolation shallow trench isolation
, HDP high-end gap

aspect ratios가 , plasma
가

APCVD .

가 가 shallow-trench aspect ratios가 4:1
6:1 가 HDP sidewall sputtering
APCVD 가

0.10 8:1 10:1 trench fill
가 .

40 가 5
insulator 가 SiO₂ 가

replacement damascene gate gate

0.10
. SiO₂ gate dielectric
front-end

batch furnace .

throughput single-wafer processing high
pressure/high temperature .