Wafer Thinning Techniques
&
Controlled Reactive Thinfilm Sputter Deposition

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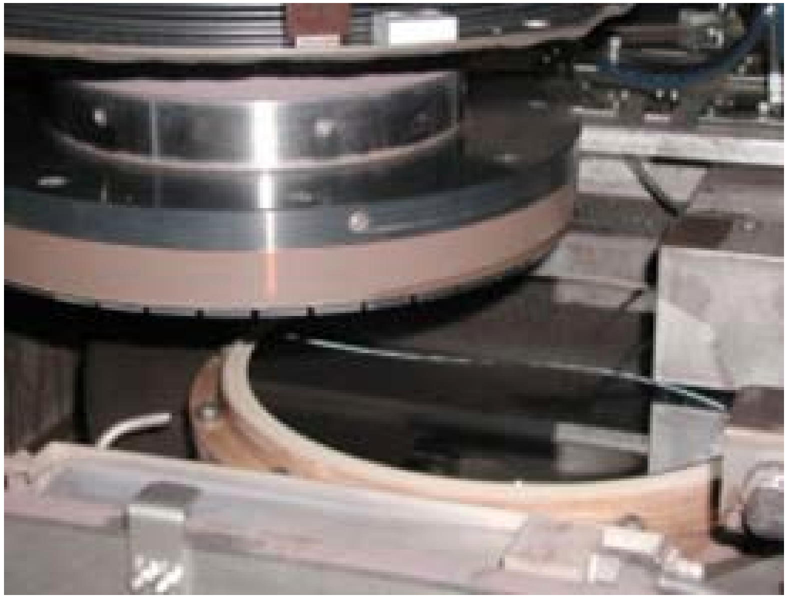
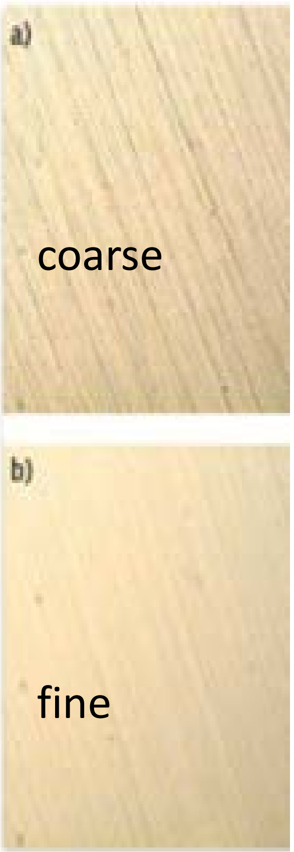
Wafer Thinning by Backgrinding or Etch

- Etch processes for wafer thinning are typically used for removing up to ~25 µm of silicon - stress relief
- Wafer backgrinding is typically used when a significant thickness is removed, i.e 300-700 µm and Total Thickness Variation (TTV) must be in the “few” µm range



Backgrinding Process Flow

- Measure thickness (for grinder setup)
- Apply protective backgrind tape
- Backgrind, typically coarse grind followed by fine grind
- Backgrind tape removal
- Stress relief etch ~ 25 µm, to remove subsurface grind damage
- Other flows: dice before grind, carrier mounted, super fine or polish finish



Backgrinding Service Providers

- Backgrind 4” wafers, ~ 500 µm to 200 µm, final grind w/ 8k grit wheel, lot charge of $275 which could be up to 35 wafer if all wafers within 5 µm thickness, semigrind.com
- Others:
  - aptekindustries.com Grind and stress relief etch
  - wafergrind.com GDSI, grind and polish 3-4 µm, potential to produce DSDP wafers for backside litho
  - axustech.com , Disco Strasbaugh, Okamoto tools

Thin Wafer Considerations

- Edge profile for standard thickness wafers are rounded for ease of handling, minimize chips , breakage and PR edge bead. Thinning changes the edge profile to a chisel point, which is very sharp and easily chipped
- Plan for breakage, wafer breakage increased on the 100 um and 150 um thick experimental wafers I ran in the range of 10% to ~ 40% more than with standard thickness wafers
- Backside finish – use, backmetal? polish or textured?

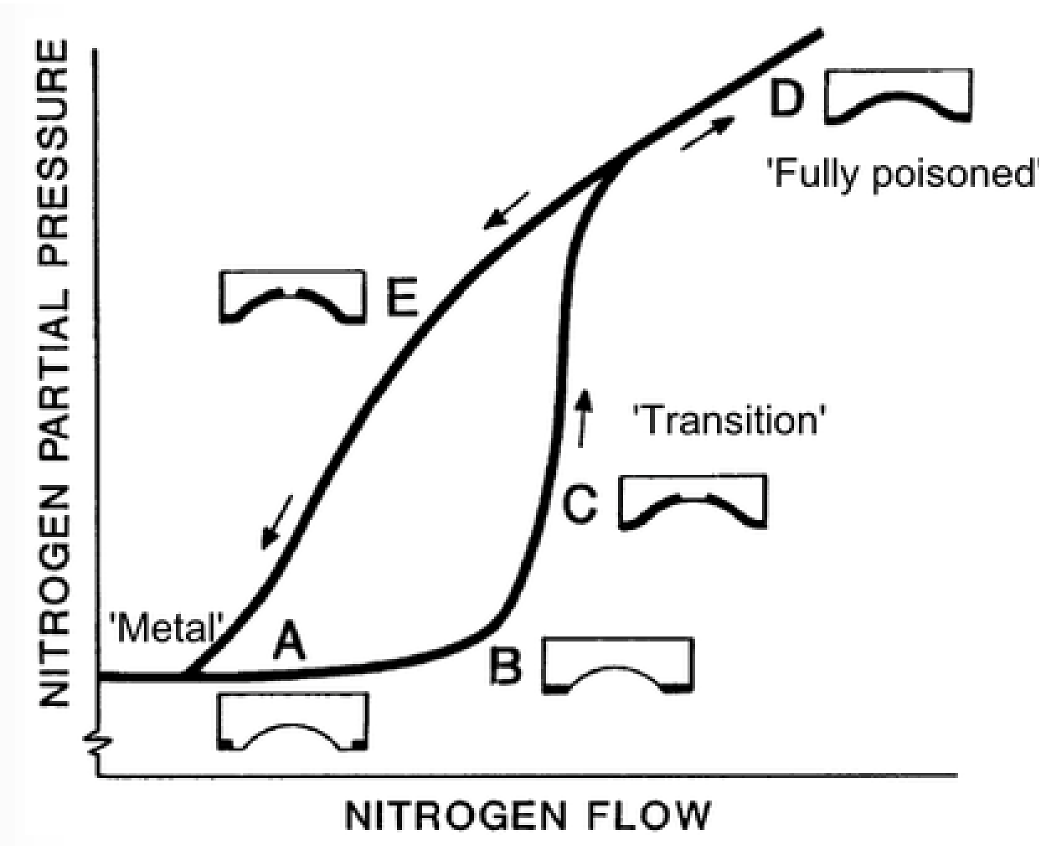
Denton Discovery D635 Sputter System

- New system on order due <u>12/25/2015 !!!</u>
- Load-locked for shorter cycle times
- 2 each 3” & 4” cathodes
- Exchangeable stages for heating or cooling
- **Reactive sputter control w/pulse DC power supply**

Benefits of New Denton Features

- 4” cathode/target for +/- 5% uniformity on 8” diameter area, 3” is +/- 5% on 6” diameter area
- Heated stage, provides heating to 500°C for film property and stress modification
- Water-cooled Rf biased stage, reduces substrate heating during process and/or allows surface back-sputter process for substrate pre-clean
- RGA for base pressure gas composition evaluation
- Reproducible deposition of reactively sputtered films with higher sputter rates, i.e. Al_2O_3, SiO_2, TiO_2, HfO_2, ZrO_2, Nb_2O_5, AZO, ITO, IrO_2, TiN, ZrN, CrN, AlN, Si_3N_4, AlCrN, TiAlN

Hysteresis during Reactive Sputtering

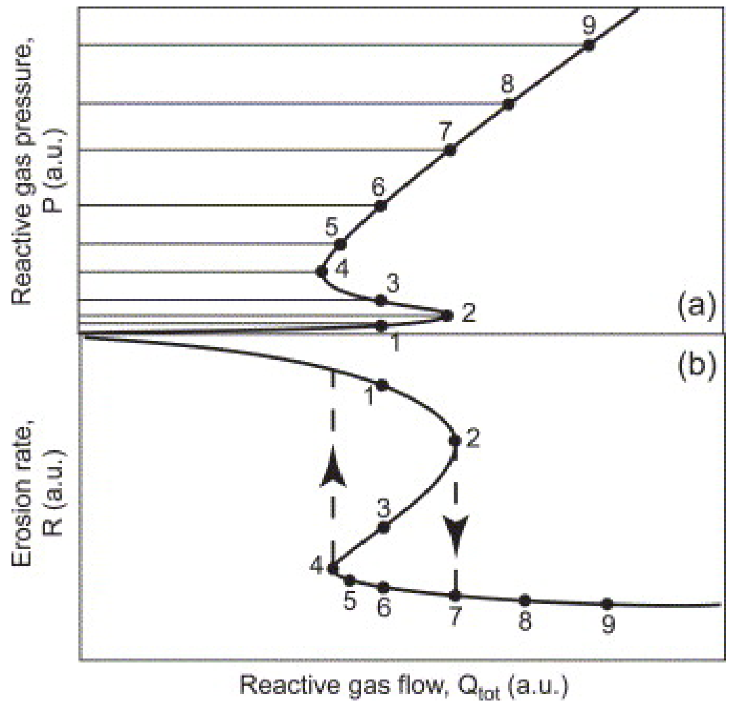


- **Without reactive sputter control** reaction “avalanches” to fully poisoned
- Fully poisoned = nitride (or oxidized) target surface, low sputter rate, typically RF
- Early transition B, sputter rate close to metal and reaction occurs in plasma

Figure 3. Target poisoning during reactive sputtering

Ref. Sproul, W.D and Tomashek, J. 1983 CA1198084A1

Reactive Gas PP & Sputter Rate



- Process result at point 1, 3 or 6 are all possible at a single reactive gas flow

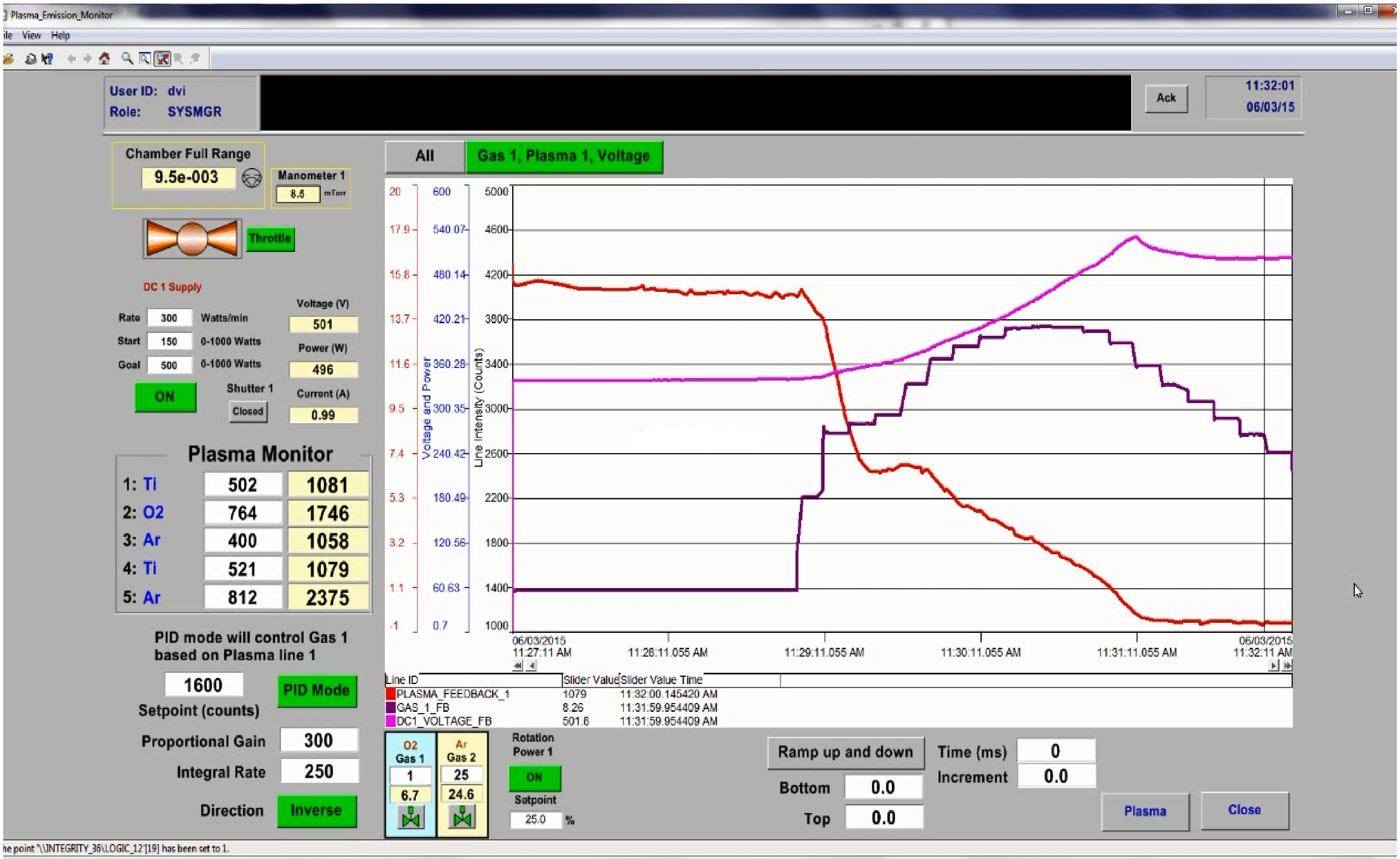
Fig. 10. Schematic diagram illustrating the simulation procedure. (a) shows the general behavior for the reactive gas pressure, P, vs. reactive gas flow and (b) shows sputtering rate, R, vs. reactive gas flow. By selecting different values for the partial pres...
S. Berg, T. Nyberg

Fundamental understanding and modeling of reactive sputtering processes

Thin Solid Films, Volume 476, Issue 2, 2005, 215–230

http://dx.doi.org/10.1016/j.tsf.2004.10.051

Denton Plasma Emission Monitor



Arc Suppression with Pulsed-DC

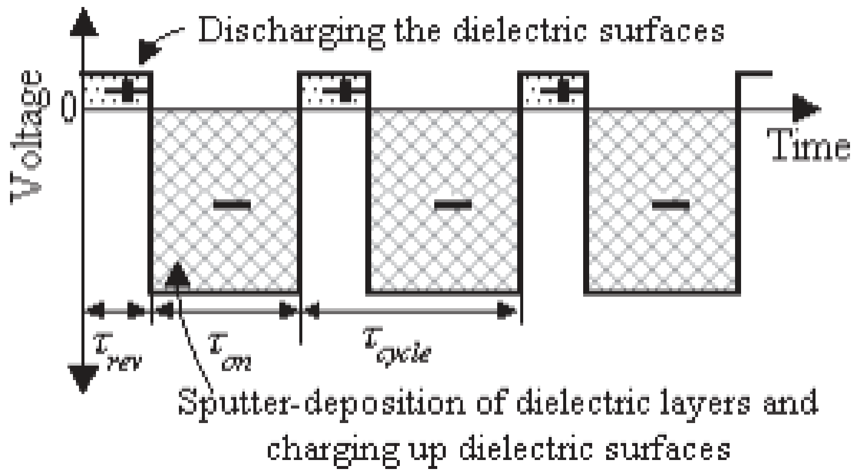


Figure 1. Pulsed voltage used to power a cathode

- Oxide or Nitride surfaces of target must be discharged to prevent charge accumulation and arcing, i.e. at 100 kHz frequency and 0.9 duty cycle

Ref: Pulsed DC Reactive Sputter of Dielectrics: Pulsing Parameter Effects
A Belkind and Zzhao, Steven Institute of Technology, Hoboken, NJ:
And D. Carter, L. Mahoney, G McDonough, G. Roche, R Scholl and H Walde,
Advanced Energy Industries, Inc, Fort Collins, CO

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