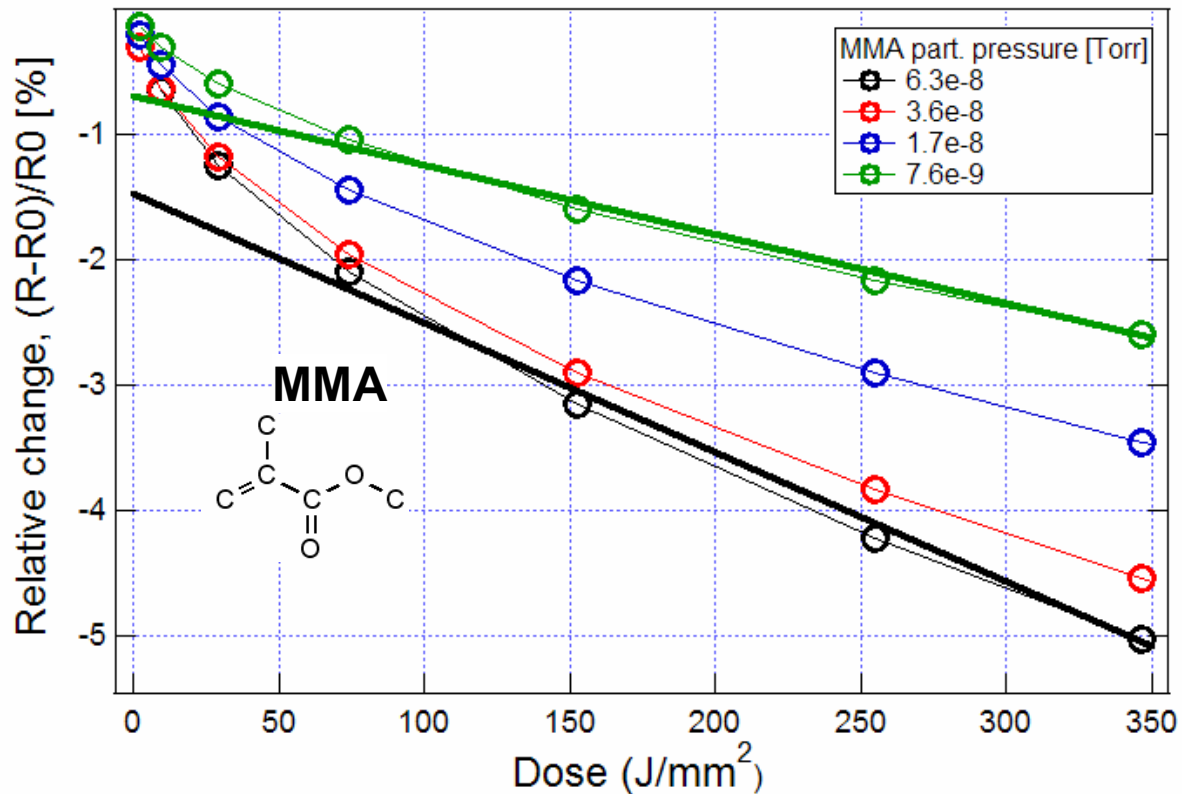
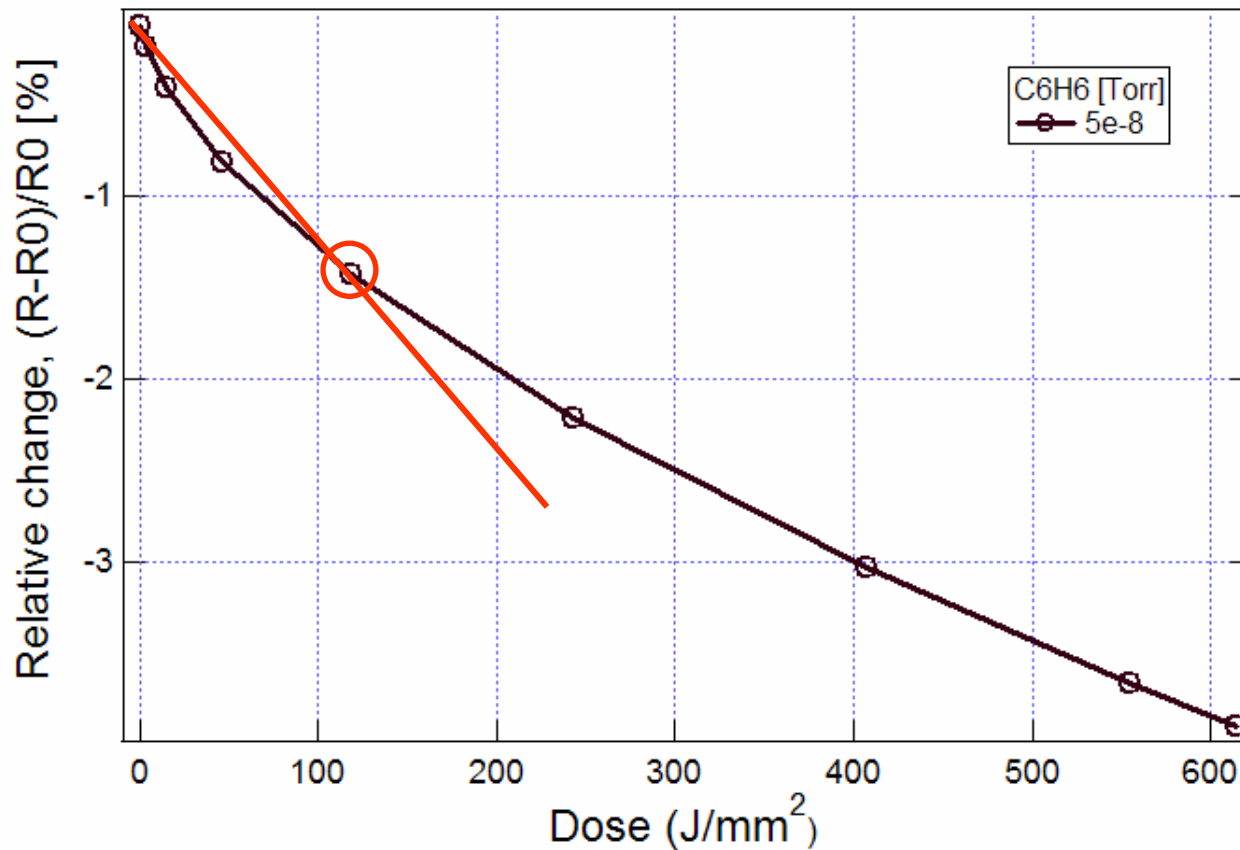


# Damage not linear with dose over entire range



- Damage rate appears to be different for low and high doses
- Damage linear with dose in high-dose regime
- Low-dose data points from wings of Gaussian damage profiles have larger relative uncertainty
- Can not directly extrapolate high-dose data to get low-dose rates

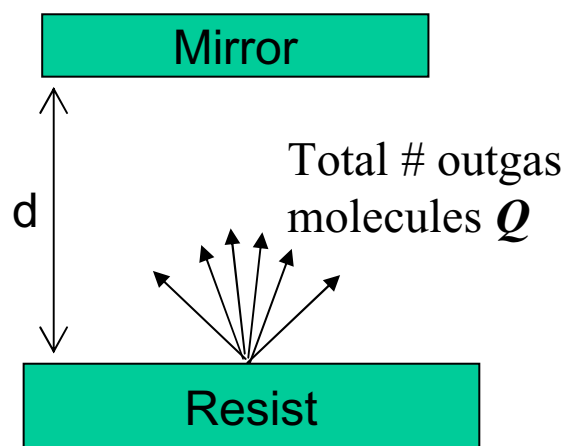
## Benzene damage rate also appears different for low and high doses



- Use low dose point at  $119 \text{ J}/\text{mm}^2$  (corresponds to intensity of  $\sim 2 \text{ mW}/\text{mm}^2$ )
- *Lower bound* of damage rate in  $5 \times 10^{-8}$  Torr benzene:  $0.012 \% / (\text{J}/\text{mm}^2)$

# Estimate fluence of molecules at mirror

- For  $C_6H_6$  pressure of  $5 \times 10^{-8}$  Torr, impingement rate  $Z = 1 \times 10^{13}$  molec/s/cm<sup>2</sup>
- During exposure time of 17 hrs, fluence of molecules striking surface from admitted gass:  $F_{ad} = Z * (17 * 3600) = 7 \times 10^{17}$  molec/cm<sup>2</sup>
- How does this compare to total fluence of molecules from resist outgassing?



As upper limit, consider all molecules emitted uniformly from point into 45° cone. Fluence of molecules at mirror is

$$F_{OG} \cong \frac{Q}{\pi d^2}$$

- For max outgas case of 2.5 DTC full wafer:  
 $Q = (8 \times 10^{14} \text{ molec/cm}^2) * (660 \text{ cm}^2) = 5 \times 10^{17}$  molec.
- With  $d = 10$  cm:  $F_{OG} = 3 \times 10^{14}$  molec/cm<sup>2</sup> < 1ML!
- So  $F_{ad} \sim 2000 * F_{OG}$

# Estimate loss expected from outgas of single wafer

- Define the relative loss in reflectivity following exposure to EUV intensity  $I$  and gas fluence  $F$  as

$$\rho \equiv \frac{\Delta R}{R_0} \propto I \cdot F$$

- Then the loss due to outgassing of a single wafer can be related to loss measured for admitted gas exposures,  $\rho_{ad}$ , by

$$\rho_{OG} = \rho_{ad} \frac{I_{OG}}{I_{ad}} \frac{F_{OG}}{F_{ad}}$$

- Assuming completely linear scaling of benzene data

$$\rho_{OG} = \rho_{ad} \frac{I_{OG}}{I_{ad}} \frac{F_{OG}}{F_{ad}} = (1.43) \frac{2 \text{ mW/cm}^2}{200 \text{ mW/cm}^2} \left( \frac{1}{2000} \right) = 7 \times 10^{-6} \%$$

- Not surprising that no resist has failed the  $\rho=2\%$  criterion