Aspect ratio dependent plasma polymer deposition

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Motivation

- plasma polymerization investigated on flat unstructured samples
- plasma polymerization on structured samples not yet investigated in literature
- knowledge required for deep reactive ion etching techniques
- investigated in isolation from etching plasmas to minimize interference with etching/sputter effects

Deposition rate model

- Assumptions:
  - deposition rate is proportional to the local monomer flux
  - neglect of ion flux on film thickness distribution
  - absorption probability equal to deposition probability

- Molecular flow regime (mean free path larger than feature width)
- Isotropic velocity distribution of neutral monomers in the plasma
- No distinction between different monomer species
- Monomers impinging on the sidewalls have two reaction pathways:
  - polymerization and contribution to the film thickness
  - desorption according to cos law (diffuse reflection)

Diffuse reflection model

- Trajectories of particles are tracked until absorption or escape back into plasma
- Calculations done by Monte Carlo simulations (program 'MoCaSim' [1])

Results: deposition rate

- Deposition rate increases with rf power (31 nm/min to 39 nm/min)
- Deposition rate decreases with temperature
- Decrease: factor 4 from 0°C to 100°C

Results: film thickness distribution

- Film thickness at trench floor (norm. particle density) independent of rf power
- Film thickness at trench floor independent of sample temperature
- Film thickness distribution follows simulations for absorption probability P=0.15

Conclusions

- Film thickness at trench floor follows distributions for an effective absorption probability P=0.15
- Effective absorption probability independent of temperature and rf power
- Absorption probability 'deposition probability

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