

1.) An i-line proximity printer is used to print metal lines on a wafer that is non-planar due to previously printed features in underlying layers. The printer is capable of 20 μm gaps. A.) If the photoresist thickness varies from 3 μm to 12 μm (a little bit of an extreme case), what is the minimum line widths that can be printed in the regions with thin and thick resist (add the resist thickness to the gap thickness in your calculations)? B.) If the proximity printer is replaced with a contact printer (zero gap), what are the new minimum printable features possible?

2.) By the year 2008, the “semiconductor roadmap” calls for exposure tools with wavelengths of 157 nm, a process that results in a k of 0.35 and optics with a numerical aperture (NA) of 0.8. A.) What is the minimum printable feature in a stepper system? B.) What is the depth of focus? C.) Discuss the limitations these systems will impose on the planarization of the wafer? (This is a key challenge for process development.)

3.) A photoresist with a contrast of 0.85 at 248 nm is used with a projection system capable of a minimum optical intensity in the areal image (on the wafer) of 25 mW/cm^2 . A.) What maximum intensity is required of the exposure tool to insure the pattern is transferred to the wafer? B.) If the photoresist requires 400 mJ/cm^2 to insure all the resist is removed in developer, what is the minimum exposure time required to insure complete removal of the resist in the developer? C.) What is the maximum exposure time allowed to insure the low intensity (dark fields) of the areal image are not removed in the developer solution.