Massachusetts Institute of Technology
3.155J / 6.152J Microelectronics Processing Technology
Fall Term 2003
Problem Set: Lithography

Out: October 8, 2003 **Due: October 15, 2003**

1) Plot resolution and depth of field as a function of exposure wavelength for a projection aligner with 100nm < λ < 500nm. Assume NA = 0.26. Recalculate on the same plot for NA = 0.41. Discuss the implication of these plots for the technologist that must manufacture transistors with 0.5 μm features.

2) A 0.6 μm thick layer of resist has $Q_0 = 40$ mJ/cm^2 and $Q_f = 160$ mJ/cm^2. Calculate the resist contrast and CMTF. If the resist thickness is cut in half, Q_f reduces to 70 mJ/cm^2 while Q_0 is unchanged. Assuming NA = 0.4, use the figure below to determine the minimum linewidth for an aligner with S = 1.0 using both resist thicknesses with a source of 365 nm. The figure below plots MTF of the aligner for a set of lines and spaces. The lines and spaces are of equal width (W), and the spatial frequency is normalized by the Rayleigh criteria, R. In other words, a normalized spatial frequency of 0.5, corresponds to a linewidth W equal to R (since the equivalent source spacing of the lines is 2W.

3) Estimate the diffraction-limited resolution for an X-Ray exposure system using photons with an energy of 1 keV and a mask to wafer separation of 20 microns.