Calculate the CMTF for a specific Shipley resist given that it has the following contrast (γ) at these wavelengths: (a) 248nm $\gamma = 0.74$ (b) 365nm $\gamma = 3.52$ (c) 436nm $\gamma = 3.72$. Also identify the source used for those wavelengths.

Since: $CMTF = (10^{1/\gamma} - 1) / (10^{1/\gamma} + 1)$
(a) (3 marks) $CMTF = 0.914$
(too high CMTF)
source: KrF Excimer source

(b) (2 marks) $CMTF = 0.316$
CMTF about right
sources: i-line, mercury vapour

(c) (2 marks) $CMTF = 0.300$
CMTF acceptable
source: g-line, mercury vapour

A 0.60 μm film of silicon dioxide is to be etched with a buffered oxide etchant of etch rate 85 nm min^{-1}. Process data shows that the thickness may vary up to 13.8% and the etch rate may vary up to 21.0%. (a) Specify a time for the etch process. (b) How much undercut will occur at the top of the film?

(a) with a total process variation of 134.8% (100% + 13.8% + 21.0%) , a safe etch time would be: (2 marks)

$(0.60\ \mu m)(134.8\%) / (85\ nm\ min^{-1}) = 9.60\ mins$

worse case:

$(0.60\ \mu m)(100\% + 13.8\%) / [85\ nm\ min^{-1} \times (100\% - 21.0\%)] = 10.26\ mins$

(b) Undercut will be:

Lateral etch:
$(85\ nm\ min^{-1})(10.26\ mins) = 0.87\ \mu m$ typical per edge (no overetch) (1.5 marks)

Worse case:
$(85\ nm\ min^{-1})(100\% + 13.8\%)(10.26\ mins) = 1.05\ \mu m$ (0.5 marks)

A single-crystal silicon boule is grown from a melt containing 1.00 ppm oxygen and 0.10 ppm boron. Growth of the crystal consumes 90% of the melt. Find the oxygen and boron concentrations at the seed end and at the tang or butt end of the boule. (5 marks)

At the tang end, solid concentration is given by equation below with $X = 1$, the definition of the segregation coefficient. At the butt end, the concentration is given by equation below with $X = 0.9000$. Values of k are found in Table 1-1, and the initial liquid concentrations are given in the problem.

$$C_s = kC_o(1-X)^{k-1}$$

Concentrations are:

	C_o	k	Tang end	Butt End
Oxygen	1.00×10^{-6}	1.25	1.25E-06	7.03E-07
Boron	0.10×10^{-6}	0.76 (0.72 ~ 0.80)	7.60E-08	1.32E-07