CHE323/384 Chemical Processes for Micro- and Nanofabrication
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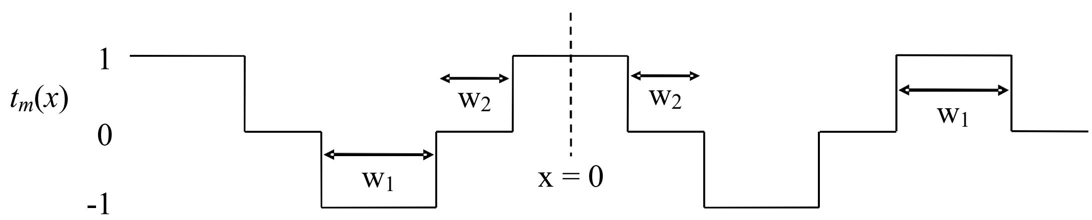
Homework #13

1. Generate a plot of DOF versus feature size using the Rayleigh DOF criterion. Assume a 193 nm wavelength, equal lines and spaces, coherent three-beam imaging, and $k_2 = 0.8$.

2. Derive the diffraction pattern of an alternating phase shift mask (a repeating pattern of lines and spaces where every other space is shifted in phase by 180°, resulting in a transmittance of −1):



3. Consider the coherent, in-focus 2-beam and 3-beam aerial images for equal lines and spaces:

2-beam: $$I(x) = \left[\frac{1}{2} + \frac{1}{\pi}\cos(2\pi x/p)\right]^2$$

3-beam: $$I(x) = \left[\frac{1}{2} + \frac{2}{\pi}\cos(2\pi x/p)\right]^2$$

Derive expressions for the NILS for each of these cases.

4. Consider a general expression for the aerial image of a line/space pattern.

$$I(x) = \sum_{j=0}^{N} \beta_j \cos(2\pi jx/p)$$

Derive an expression for the NILS for the case of equal lines and spaces.

5. For the Mack model of development, what is the value of the development rate at $m = m_{th}$? For $m_{th} > 0$, what is the limit of this value as n becomes large?

6. Consider the case when the diffusion rate constant for the development mechanism is large compared to the surface reaction rate constant (i.e., the rate is reaction-controlled). If $a \gg 1$, show that the Mack development rate will become

$$r = r_{max}(1-m)^n + r_{min}$$