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A grating is fabricated by deep etching of grooves in silicon. The silicon wafer is  $300\text{ }\mu\text{m}$  thick and the etched grooves are  $50\text{ }\mu\text{m}$  deep. Two test samples are fabricated; in the first the grooves are filled with Gold (Au), in the other the grooves are filled with Indium (In).



Sketch of grooves viewed from the side.

To investigate the filling quality, X-ray microscopy images are taken of the two gratings using  $20\text{ keV}$  monochrome radiation. The result are two "Zebra-like" images showing brighter and darker stripes.

Calculate the relative intensities for the darker and the brighter stripes in the two images. (Images are often normalized to the intensity value "one" when no object is applied.)

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$$\alpha_{\text{Si}} = 10,397\text{ cm}^{-1}$$

$$\alpha_{\text{Au}} = 1523,0\text{ cm}^{-1}$$

$$\alpha_{\text{In}} = 149,4\text{ cm}^{-1}$$

$$\phi_0 = 1$$

$$\alpha_{\text{Si}} \cdot x_{\text{Si}} = 10,397 \cdot 0,03 = 0,31190$$

$$\phi_{\text{Si}} = e^{-\alpha x} = e^{-0,31190} = 0,732$$

$$\begin{aligned} & \alpha_{\text{Au}} \cdot x_{\text{Au}} = 1523,0 \cdot 0,005 = 7,615 \\ & \text{Remaining Si } \alpha_{\text{Si}} \cdot x_{\text{Si}} = 10,397 \cdot 0,025 = 0,2599 \\ & \phi = e^{-\alpha_{\text{Au}} \cdot x_{\text{Au}}} \cdot e^{-\alpha_{\text{Si}} \cdot x_{\text{Si}}} = e^{-(7,615 + 0,2599)} = 0,000380 \end{aligned}$$

$$\begin{aligned} & \alpha_{\text{In}} \cdot x_{\text{In}} = 149,4 \cdot 0,005 = 0,747 \\ & \text{Remaining Si, same as for Au } 0,2599 \\ & \phi = e^{-(\alpha x)_{\text{In}} + (\alpha x)_{\text{Si}}} = e^{-(0,747 + 0,2599)} = 0,365 \end{aligned}$$

First image pattern

Only silicon : 0,732 intensity (white)

Au (gold) : 0,0004 intensity (black)

2nd image pattern

Only silicon : 0,732 intensity (white)

In (indium) : 0,362 intensity (gray)