NANO 703/703L

Homework 4

Due: W-11/9, 10:00 AM

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1) Pure Cr has the *bcc* structure, with a lattice constant of $a = 0.291$ nm.

The electron-scattering amplitude (form factor) at scattering parameter $s = g/2$ is approximately:

$$f(s) = A\mathrm{e}^{-Bs}$$

The coefficients for this element at 200 KeV are *A*=0.921 nm, *B*=0.335 nm.

The Fourier components of the structure function are $U_{hkl} = F_{hkl}/(\pi v)$, where v is the unit-cell volume. The extinction distance is $\xi_{hkl} = 1/(\lambda U_{hkl})$.

Create a table as shown below containing values for each reflection in the first column:

$hk\ell$	i) g_{hkl} (nm^{-1})	ii) $f(s)$ (nm)	iii) $\lvert U_{hkl}\rvert$ (nm^{-2})	iv) $\lvert \xi_{hkl}\rvert$ (nm)
a) 110				
b) 200				
c) 211				

Please show work and organize your answers.

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2) A reflection *g* has extinction distance $\xi = 78$ nm and excitation error $s = 0.0083\ \mathrm{nm}^{-1}$. Assuming a two-beam condition, find the thickness T (in nm) for the first maximum in the diffracted intensity for *g*.

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3) A CBED pattern is acquired from a sample of thickness $T = 97$ nm, using a two-beam condition for reflection *g*, where $\xi_{\mathbf{g}} = 82$ nm. Is the central ($s = 0$) portion of the CBED disk for *g* a local intensity minimum, or a maximum?

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4) PbSe has the NaCl (rocksalt) structure, having cubic lattice parameter $a = 0.58$ nm. A CBED pattern is acquired along the [221] zone axis, using a 200-KeV electron beam, and a semi-angle of convergence $\alpha = 3.7$ mrad. Is this a Kossel-Mollenstadt pattern, or a Kossel pattern? Explain.

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5) A selected-area diffraction pattern is acquired at 200 KeV from a cubic crystal with $a = 0.29$ nm oriented such that the 422 (excess) Kikuchi line passes at a radial distance $x = -0.098\ \mathrm{nm}^{-1}$, where the negative value indicates a position inside the 422 reflection.

a) Estimate the excitation error of this reflection.

b) Determine the minimum change in tilt angle (in rad) from this initial orientation needed to obtain a two-beam condition for this reflection. (Use $\Delta\phi = \phi_f - \phi_i$, where $\phi_f = g/2k$.)