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A&EP 711
PS #2, Reflectivity
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Parts a and b) Using Matlab I created a program that calculates the reflectance of a Pd-Cr bi-layer on a silicon substrate and compares to the Fresnel reflectance of Pd and experimentally acquired data. The Matlab code is included at the end of this doc. The program accepts variable values for the thickness of the Pd and Cr and also takes a root-mean-square roughness, σ. Figure 1 shows the calculated reflectance as a function of q_z in blue for a Pd and Cr thickness of 200 Å and 50 Å respectively. The rms roughness is taken to be zero. The Fresnel reflectance is shown in red while the experimental data is shown in green

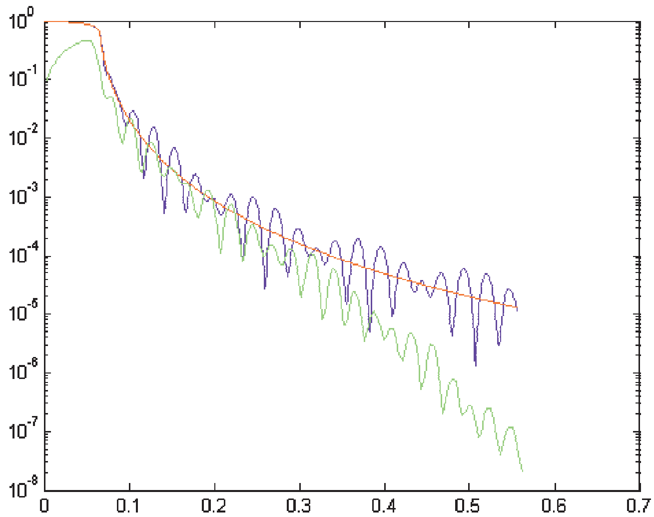

***Figure 1**. Reflectance as a function of qz for a Pd-Cr bi-layer on a silicon substrate. Pd and Cr thickness of 200 Å and 50 Å respectively, while rms roughness is zero.*

Parts c and d) The layer thickness and rms roughness values were varied to find a best fit to the experimental data. The values of the best fit to the thickness of the Pd and Cr layers was found to be 200 Å and 50 Å respectively. The best fit rms roughness was found to be 4 Å. Figure 2 shows a plot of the reflectance as a function of q_z using the best fit parameters.

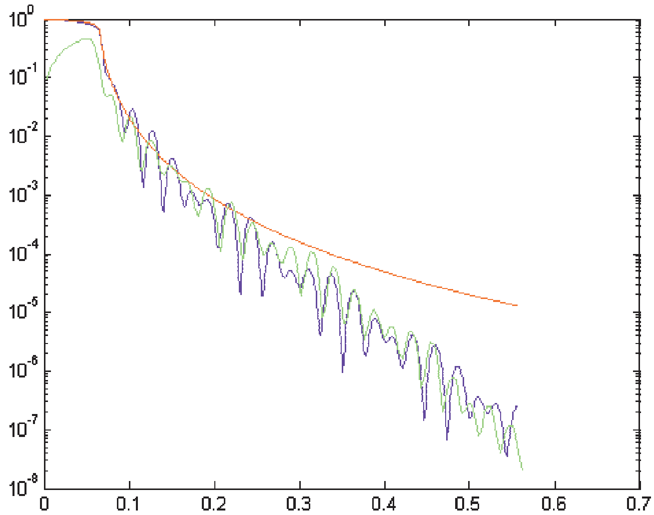

Figure 2. Reflectance as a function of q_z using the best fit parameters. Pd and Cr thickness of 200 Å and 55 Å respectively, while rms roughness is 4 Å.

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 %David Nowak
%A&EP 711
%Assignment #2, Reflectivity
%Matlab Code

%Load the expt data from detlef from a file expt.txt
load expt.txt;
qz      = expt(:,1);
Rexpt   = expt(:,2);

%variables
tPd     = 200;
tCr     = 55;
sigma   = 4;
n1=1-1.9718e-5 + i*1.083e-6;        %Pd
n2=1-1.2777e-5 + i*8.2374e-7;       %Cr
n3=1-4.4847e-6 + i*6.1802e-8;       %Si

%Parameters
z1      = tPd;
z2      = tPd + tCr;
k = (2*pi*10450)/(4.136e-15*3e18);

%Create an array for kz0
kz0     = linspace(0:500)*k;
kz1     = sqrt((n1^2-1)*k^2 + kz0^2);
kz2     = sqrt((n2^2-1)*k^2 + kz0^2);
kz3     = sqrt((n3^2-1)*k^2 + kz0^2);

%Compute the Fresnel reflectivity for Pd
rfpd    = (kz0 - kz1)/(kz0 + kz1);
Rfpd    = rfpd*conj(rfpd);

%Define the Transfer Matrix
A01     = 1/2*[[(1+kz1/kz0), (1-kz1/kz0)];[(1-kz1/kz0),(1+kz1/kz0)]];
A12     = 1/2*[[(1+kz2/kz1)*exp(i*(kz2-kz1)*z1),(1-kz2/kz1)*exp(-i*(kz2+kz1)*z1)];
                [(1-kz2/kz1)*exp(i*(kz2+kz1)*z1),(1+kz2/kz1)*exp(-i*(kz2-kz1)*z1)]];
A23     = 1/2*[[(1+kz3/kz2)*exp(i*(kz3-kz2)*z2),(1-kz3/kz2)*exp(-i*(kz3+kz2)*z2)];
                [(1-kz3/kz2)*exp(i*(kz3+kz2)*z2),(1+kz3/kz2)*exp(-i*(kz3-kz2)*z2)]];

A       = A01*A12*A23;
r       = A(2,1)/A(1,1);
R       = r*conj(r)*exp(-sigma^2*4*kz0^2);

%Plot the Fresnel for Pd, Expt, and theoretical
semilogy(2*kz0,R,'b',2*k0,Rfpd,'r',qz,Rexpt,'g')
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