The University of Windsor

ELEC2250: Physical Electronics

Summer 2020

Lab 1

Atomic and Surface Density of a Cubic Crystal

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Five MATLAB functions used in the script

List of 5 MATLAB functions and their descriptions:

i) sprintf(‘’, EmbeddedValues); Used to output text and embedded values into a string. The values embedded inside of the string are displayed using comma-separated values.

ii) msgbox(OutputMessage, BoxName); Displays a string stored message into a message box titled with whatever name you give it in the parameters.

iii) uiwait(ReturnSignal); Halts the program until it receives a user return signal from a user interface.

iv) sqrt(numValue); This function takes the square root of whatever number value is entered in its parameters

v) clc; Clears the command log of previous run output

Modified Code

```
%% Matlab Code to Calculate and Show Crystalline properties of Germanium
% ELEC-2250 S2020
% Lab assignment 1
%
clear all; %Deletes all variables
close all; % Closes all figure windows
clc; %Clears the command window
%
Lattice_constant=5.658e-8; % In Centimeters

% Calculting number of atoms in (100) fcc
atomshundred = 1/8*4 + 1;

% Calculating Surface Density
SurDen = atomshundred/Lattice_constant^2;

% Calculate number of atoms per unit cell
Number_of_atoms_per_unit_cell=8*(1/8)+6*(1/2)+4 ;

% Calculate the volume of a unit cell
volume_of_unit_cell = (Lattice_constant)^3;

% Calculate atomic density
Atomic_density = Number_of_atoms_per_unit_cell/volume_of_unit_cell;

%Mass density
Molar_weight=72.64 %g/mole
Avogadro_number=6.023e23;
Mass_Density=Atomic_density*Molar_weight/Avogadro_number

% Fraction occupied by atoms
Atom_radius=Lattice_constant*sqrt(3)/8; % Atom radius=nearest atom distance
Atom_sphere_volume=4/3*pi*(Atom_radius)^3;
Fraction_occupied=8*Atom_sphere_volume/volume_of_unit_cell

% Display results in pop-up text box
message=sprintf ('Material: Germanium\n\nMass Density of Germanium:
%.2fg/cm^3 \n\nFraction occupied by atoms: %.2f \n\nAtomic_density:
%.2fatoms/cm^3 \n\nSurface Density(100): %.2f atoms/cm^2\n\nName: Emmanuel
Mati\n\nStudent Number:
104418019\n\n',Mass_Density,Fraction_occupied,Atomic_density,SurDen); %
format data into string

uiwait (msgbox(message,'Assignment1')); % display string in message box
```

Modified Output

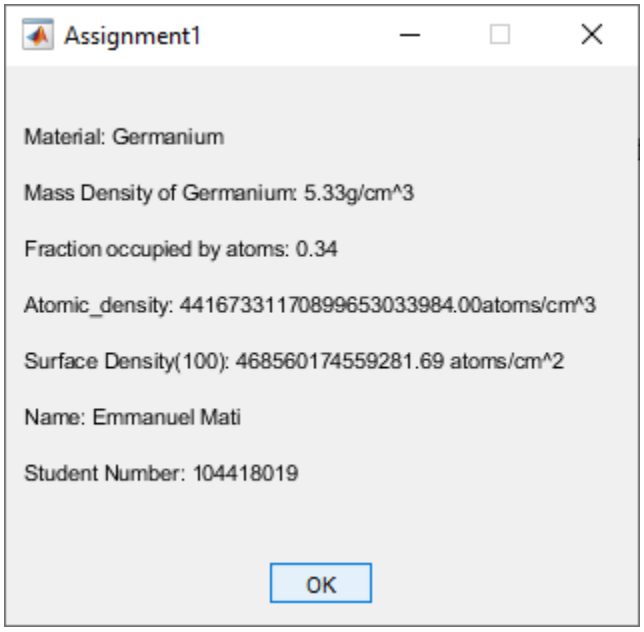

Figure 1 Output of the modified MATLAB code

Discussion of Observations

In terms of the MATLAB results, it is observed that the mass density of germanium is essentially double that of silicon at 5.33 g/cm^3. This means that the atoms inside of germanium must be double the mass of the silicon atoms since germanium has the same diamond cubic lattice structure that silicon has. The fraction occupied by atoms was the same at 0.34 which makes sense since they are the same cubic diamond structure. Interestingly enough, the atomic density of germanium appeared to be slightly smaller than that of silicon. This means that the lattice constant of Germanium is slightly smaller than that of silicon's which also explains the higher mass density.

Throughout modifying the MATLAB code, a couple of very neat and useful functions were discovered. Functions like sprintf; give the user tremendous and dynamic capabilities in generating a string with embedded-modifiable values in it. Then there were functions like msgbox and uiwait which in combination work by displaying a message box and halting the program until the user responds to the prompt. Another important function was the sprt function which as the name suggests, simply square roots a value. Last was the clc function which simply cleans the command log. The MATLAB code in this lab and the functions used will surely help in future labs.