Aalto University
School of Engineering

COE-C2004 - Materials Science and Engineering

2021-2022 Autumn II

Assignment 1, 01.11.2022

General rules:

1. Learning Group work is encouraged for this course. You could form a group with max one additional peer to review the lecture/exercise content and discuss the tasks in the assignment. After discussion, please finish your assignment independently and submit your individual report. Please note the duplicate report is not accepted!
2. If you have a learning group, please indicate who your group member is in the submitted report. In addition, clearly state the individual contributions of each group member.
3. When required, always show the step-by-step derivation or calculation processes, without which hinting the number does not qualify for grades.
4. When required, always give a brief and concise explanation or description, without which hinting the right choice or answer does not qualify for grades.
5. Citation is necessary if you are using any figures/data that are not generated by yourself.
6. Handwriting/plotting is acceptable, just make sure that your handwriting/final photo in the system is clear enough, otherwise it may affect the grading for details/calculation process.
7. Only PDF type file is accepted for submission, please summarize all your answers/solutions in one PDF file for every assignment. It is appreciated to sort the PDF pages in the TaskNr order, which is helpful to speed up the evaluation process. Please name your assignment files with the assignment number and your first name and surname, and link them with short underlines: 'ANr_Firstname_Surname.pdf', e.g. for the first Assignment 'A1_Wenqi_Liu.pdf'.
8. Please make sure that you have confirmed your submission after uploading your assignments. The draft state will not be accepted.
9. Assignment 1 will take 7 points in the final grade system.

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Task 1. Materials introduction (25 points, Lecture1)

Select one or more of the following modern items or devices and conduct an Internet search in order to determine what specific material(s) is (are) used and what specific properties this (these) material(s) possess(es) in order for the device/item to function properly. Finally, write a short essay in which you report your findings. (**0.5-1 A4 Page**)

- Cell phone/digital camera batteries
- Cell phone displays
- Solar cells
- Wind turbine blades
- Fuel cells
- Automobile engine blocks
- Automobile bodies
- Space telescope mirrors
- Military body armor
- Lightweight bicycle frames

Task 2. Atomic structure and interatomic bonding (10 points, Lecture1)

2.1 Calculate the energy (in J) and force (in N) of attraction between a cation with a valence of +2 and an anion with a valence of –1, the centers of which are separated by a distance of 5.3 nm. (Please give the detailed calculation process, and explain your choices or equations and numbers.)

2.2 Using the figure below, calculate the percent ionic character of the interatomic bonds for the following materials:

(a) “KCl”;

(b) “NaI”.

(Please give the detailed calculation process.)

IA							VIII					IIIA	IVA	VA	VIA	VIIA	0
1 H 2.1	IIA									IB	IIB						2 He –
3 Li 1.0	4 Be 1.5											5 B 2.0	6 C 2.5	7 N 3.0	8 O 3.5	9 F 4.0	10 Ne –
11 Na 0.9	12 Mg 1.2	IIIB	IVB	VB	VIB	VIIB				IB	IIB	13 Al 1.5	14 Si 1.8	15 P 2.1	16 S 2.5	17 Cl 3.0	18 Ar –
19 K 0.8	20 Ca 1.0	21 Sc 1.3	22 Ti 1.5	23 V 1.6	24 Cr 1.6	25 Mn 1.5	26 Fe 1.8	27 Co 1.8	28 Ni 1.8	29 Cu 1.9	30 Zn 1.6	31 Ga 1.6	32 Ge 1.8	33 As 2.0	34 Se 2.4	35 Br 2.8	36 Kr –
37 Rb 0.8	38 Sr 1.0	39 Y 1.2	40 Zr 1.4	41 Nb 1.6	42 Mo 1.8	43 Tc 1.9	44 Ru 2.2	45 Rh 2.2	46 Pd 2.2	47 Ag 1.9	48 Cd 1.7	49 In 1.7	50 Sn 1.8	51 Sb 1.9	52 Te 2.1	53 I 2.5	54 Xe –
55 Cs 0.7	56 Ba 0.9	57–71 La–Lu 1.1–1.2	72 Hf 1.3	73 Ta 1.5	74 W 1.7	75 Re 1.9	76 Os 2.2	77 Ir 2.2	78 Pt 2.2	79 Au 2.4	80 Hg 1.9	81 Tl 1.8	82 Pb 1.8	83 Bi 1.9	84 Po 2.0	85 At 2.2	86 Rn –
87 Fr 0.7	88 Ra 0.9	89–102 Ac–No 1.1–1.7															

Task 3. Crystal structure (40 points, Lecture2)

3.1 Explain the lattice and unit cell of the crystal structure c

3.2 For four types of crystal structure:

(a) Primitive cubic;

(b) Body-centered cubic (BCC);

(c) Face-centered cubic (FCC);

(d) Hexagonal close-packed (HCP),

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finish the following tasks:

- Draw the unit cell with the coordinate system (Please create it on your own, copy/paste from textbook/slides is not accepted!);
- Mark the most closely packed planes and directions and list their Miller indices;
- Determine the number of nearest neighbors;
- Calculate the atomic packing factor (Please give the detailed calculation process.).

Task 4. Polycrystal structure (25 points, Lecture2&Exercise1)

4.1 (a) Describe briefly, what the dislocation is and the types of disloctions.

(b) Describe briefly, what the crystallographic orientation is.

(c) Explain, how the grain size distribution of polycrystals can be determined and represented.

4.2 Analyze the grain size and grain shape of the attached EBSD data (ebsd2.ctf). (Hint: Do grain reconstruction, plot the grain map, give the total grain number and finally inner grain number, draw the distribution figures, and calculate the characteristic parameters of the distribution. It is better to use the log-normal distribution for grain size and Beta distribution for grain shape.)

Due date: 18:00, 07.11.2021.

Contact: MyCourses 'General discussion' channel,

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