MLL 100

Introduction to Materials Science and Engineering

TWF 10:00-11:00

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IIT Delhi
Department of Materials Science and Engineering

January 04, 2022

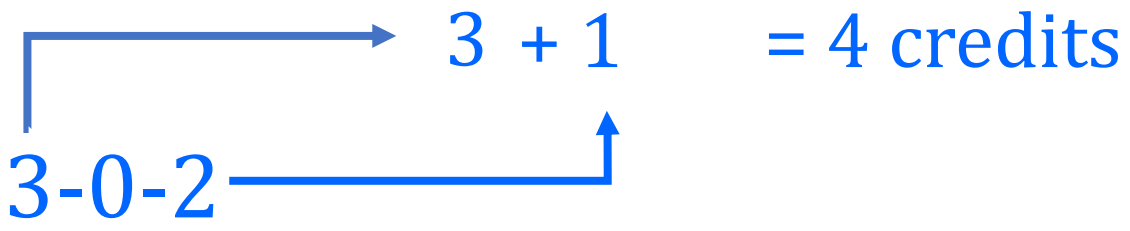
Lecture 1: Introduction

Course Policy

- Evaluation scheme (Grading)
- Attendance Policy
- Suggested Readings
- Introductory lecture

COURSE POLICY

Evaluation scheme



Laboratory session (Demonstration/Take-home assignment Total experiments: 8)	**25%**
Quiz (Moodle Total: 4)	**25%**
Minor Exam (Moodle)	**25%**
Major Exam (Moodle)	**25%**

Laboratory session (Demonstration/Take-home assignment Total experiments: 8)	**25%**

- Total lab experiments: 8
- **Each take-home lab experiment will be uploaded on Moodle on Friday at 5:00 p.m. and will be due by 5:00 p.m. on Friday the week after.**
- NO LATE SUBMISSIONS WILL BE ENTERTAINED. Zero marks will be given for late submissions.
- All the take home assignments and lab sheets should be submitted in Moodle. Clear instructions will be given. If you violate instructions, marks will be deducted accordingly.
- Any query related to grading of lab experiments and take home assignments should be asked to the corresponding TAs.
- Any kind of cheating or unfair means during the exams (Quiz, minor, major) may lead to strong disciplinary action which may result **FAILING** in the entire course.

Quiz (Moodle **Total: 4)**	**25%**

- On Moodle, with minimum 1 day notice.
- Each quiz will be of *20 minutes* duration, held during regular class slots and multiple choice questions/one word answers only. No long answer type questions will be asked.
- Negative marking will be implemented: *-0.25 for every incorrect answer*.
- Once you see a question, you will *NOT be allowed to go back and attempt* the question again, or correct your answers.
- **No make up quizzes will be given. All quizzes will contribute to your 25% score.**

Minor Exam (Moodle)	**25%**
Major Exam (Moodle)	**25%**

- Minor and Major examinations will be *conducted* on the specified dates *as per the institute calendar*.
- Both these exams will also be conducted *via Moodle*. The questions will be of mostly of *Numerical Type*. However, it will be notified, if there is any change in plan.
- *No negative marking will be implemented. There will be no answer options given either*.
- You will be allowed to go back and attempt the question again, or correct your answers.
- **No make up for Minor or Major exams will be taken. Such requests will not be considered.**

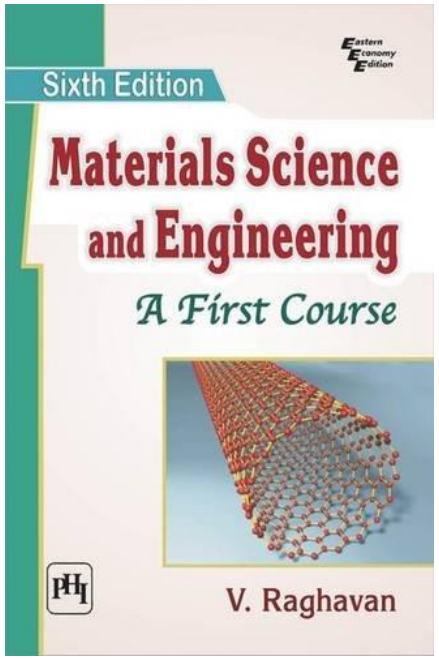
Attendance Policy

No attendance policy

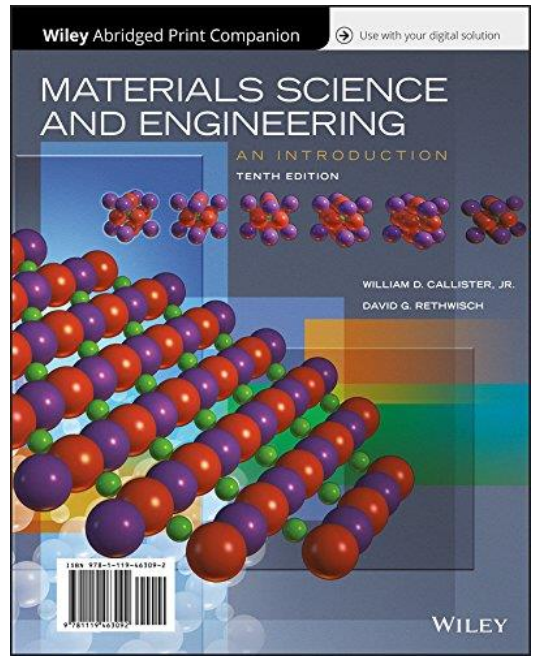
BUT ……

Recommended studying from the suggested textbooks!

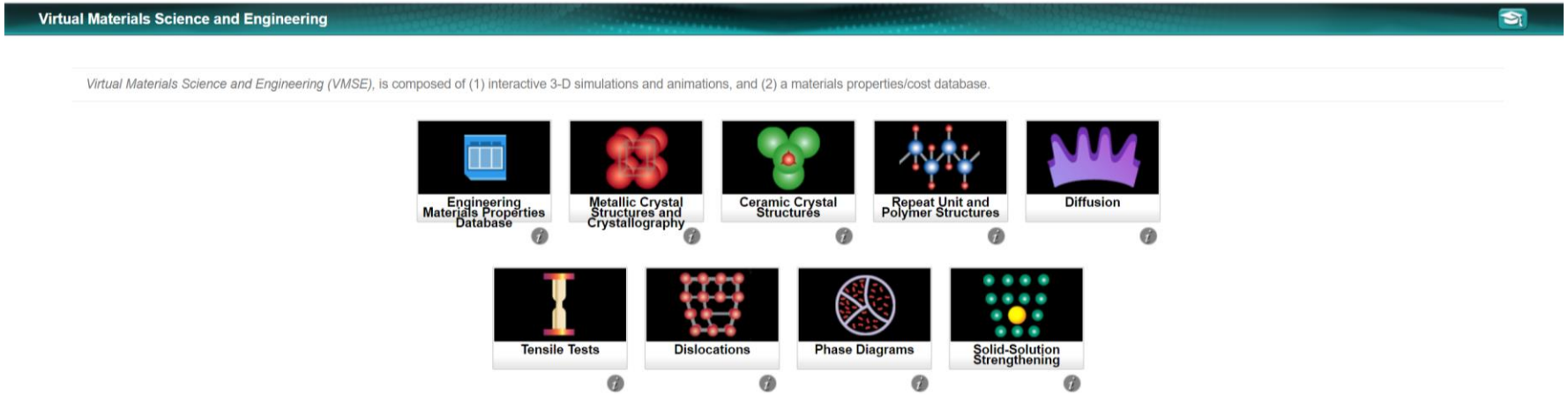
Reference Textbooks



- Materials Science and Engineering: A First Course; V. Raghavan
- Materials Science and Engineering: An Introduction by W.D. Callister, Jr., 7th edition, John Wiley and Sons.



- Virtual Material Science supplement https://wileyassets.s3.amazonaws.com/VMSE/index.html
- Lecture slides (pdf): Moodle



Why should I *enrol* myself for the course ‘Materials Science and Engineering’?

Why should I *learn* Materials Science and Engineering?

Three generations of light bulbs, each rated to produce 1100 lumens of light

Blow moulding of glass

Incandescent
75 Watts

Compact Fluorescent
18 Watts

LED
11 Watts

Tungsten filament wire of diameter ~ 15 μ

Part no.	Part name	Material	Main manufacturing processes	Comments on material selection
1	bulb	soda–lime glass	blow-moulding	low cost, transparency, viscosity
2	filament	tungsten	hot-pressing + wire-drawing	high melting temp. (above 'glowing' temp.), electrical conductor, low vapour pressure, high strength and sufficient ductility
3	lead-in wire	nickel or nickel-plated	wire-drawing (nickel plating)	electrical conductor, oxidation resistant during processing, ductility
4	filament support	molybdenum	wire-drawing	high melting temp., ductility
5	'dumet' wire	nickel-iron alloy	wire-drawing	coefficient of thermal expansion has to match that of glass in (6)
6	'pinch'	lead glass (SiO_2 + 20–30 wt% PbO)	pressing	
7	fuse sleeve	soda–lime glass	drawing	as (1)
8	exhaust tube	lead–glass	drawing	as (6)
9	fuse	copper–nickel alloy	wire-drawing + welding	correct fusing characteristics; suited to automatic welding
10	cement	phenol–formaldehyde		good adhesion at 400 K for life
11	outlead	copper or copper-clad steel	wire-drawing (electroplating)	electrical conductor, easy to solder
12	cap filling	opaque glass	casting	high-temp. insulation, melting temp.
13	cap	aluminium or brass	pressing	choice depends on cost of raw material
14	contacts	solder (Pb/Sn)		melt temp. has to be higher than contact operating temp.
holder				
15	insert	brass (70 Cu/30 Zn)	pressing	ductility
16	pins	brass (60 Cu/40 Zn)	extrusion	electrical conductivity, ductility
17	holder	phenol-formaldehyde (filled with wood/paper)	compression moulding	
18	spring	phosphor bronze (Cu/6Sn/0.2 P)	wire-drawing	electrical conductivity, strength and low Young's modulus
19	connector block	brass (60 Cu/40 Zn)	forging + machining	electrical conductivity, machinability
20	cover	urea-formaldehyde (filled with glass)		can be coloured white with glass powder filler
21	conductor	copper	wire-drawing	electrical conductivity, ductility
22	twin core flex	PVC (plasticized)	extrusion	electrical insulation, viscosity
23			extrusion	electrical insulation, viscosity

Faucet

Metallic pan

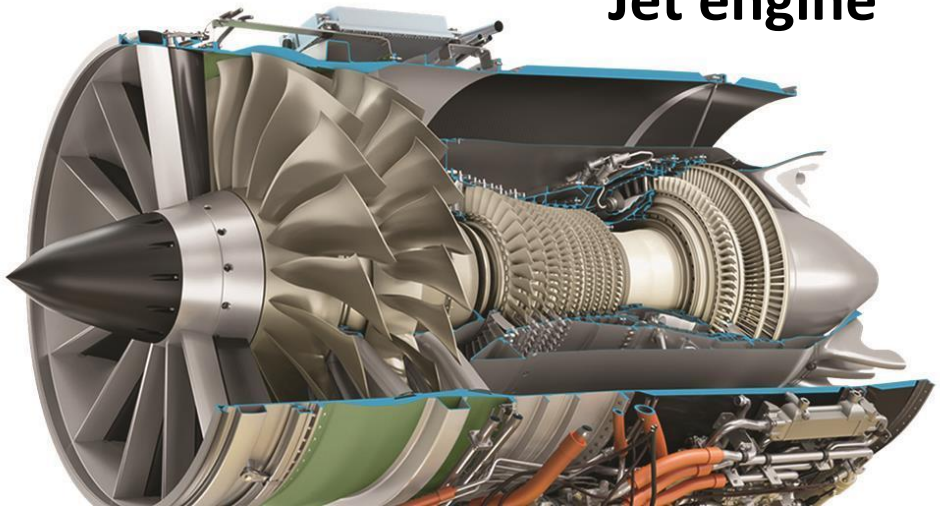
Polymer ladle

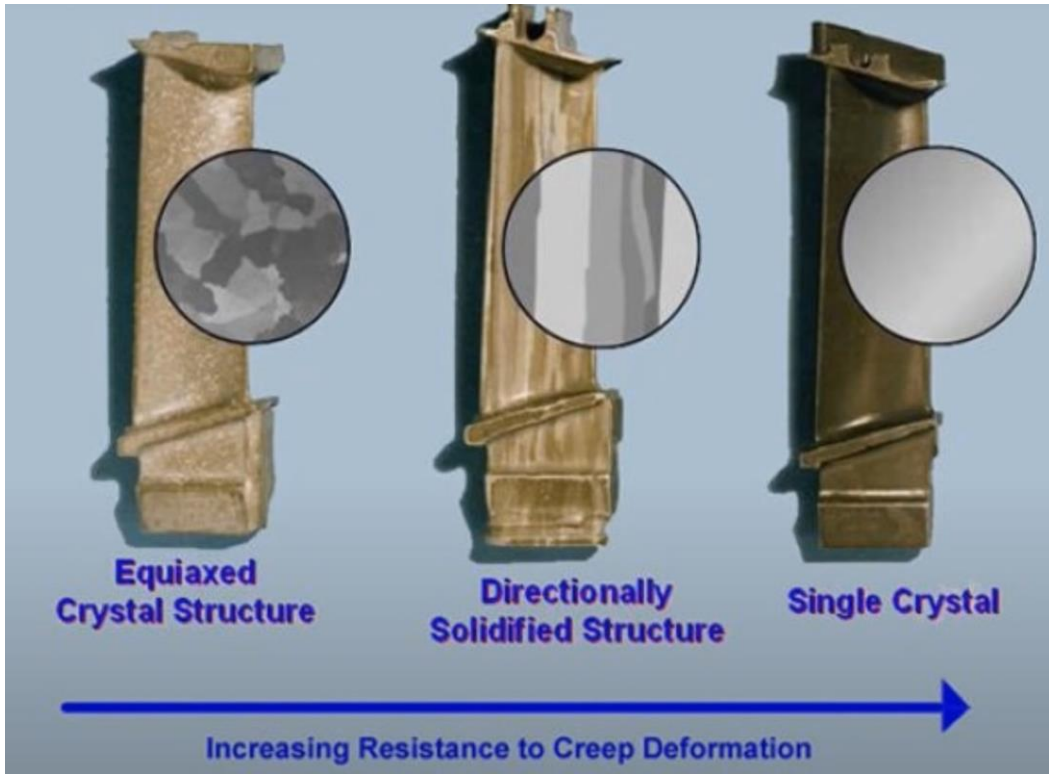
Non-stick pan

Wooden spoon

Bicycle frames

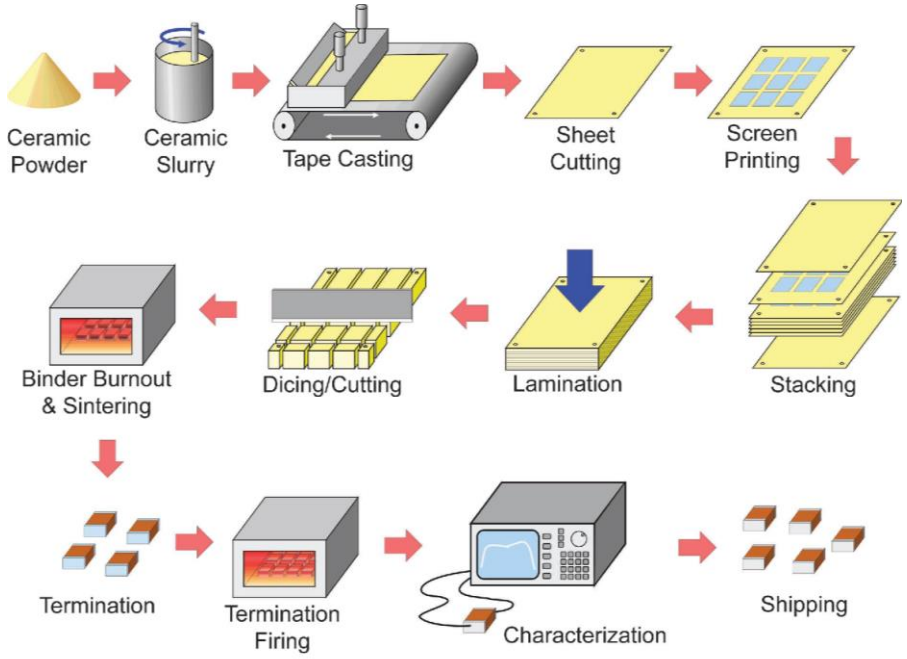
Jet engine





Fun watch

Evolution of jet engine turbine blades



Cleanroom

Semiconductor industry

Microscope

Which type of cup will you go for to enjoy your sip of tea?

Steel

Ceramic

Polymer

Cardboard

https://fast-poll.com/poll/1d2fa40c

https://fast-poll.com/poll/results/1d2fa40c

Which type of cup will you go for to enjoy your sip of tea?

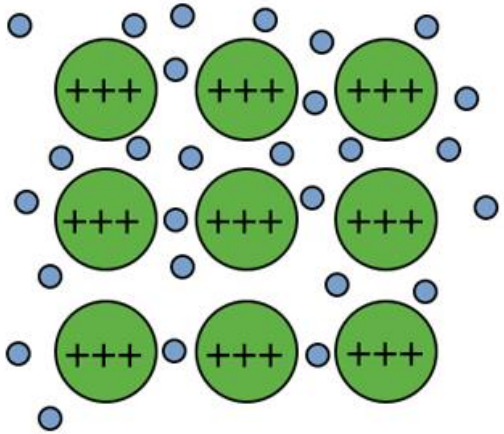
Steel

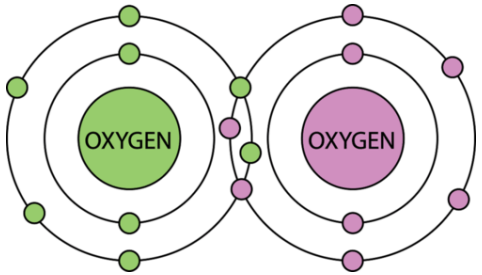
Ceramic

Polymer

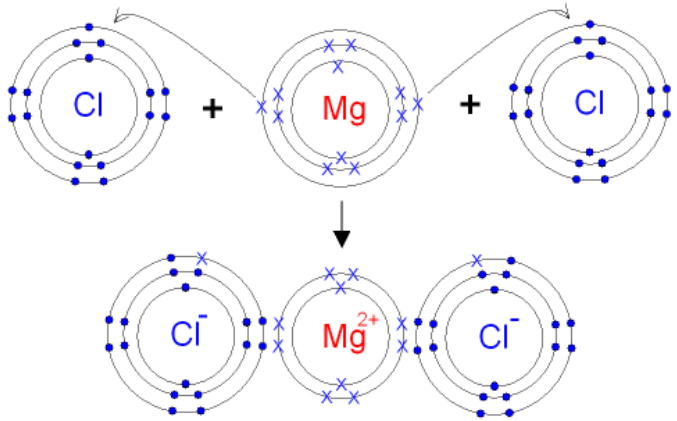
Cardboard

Metallic bonding



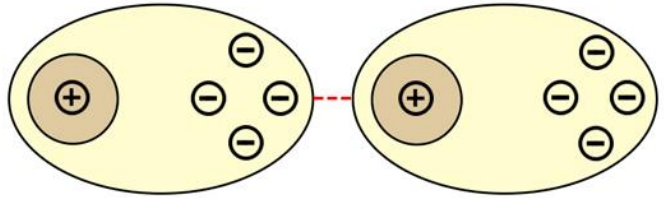


Covalent bonding

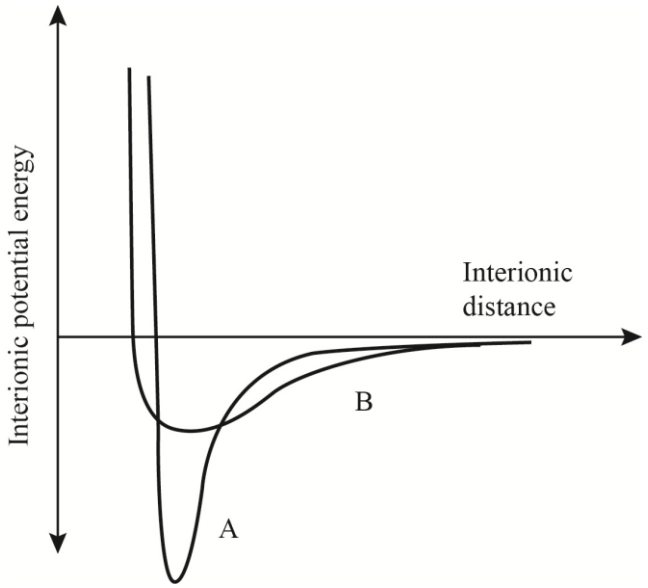


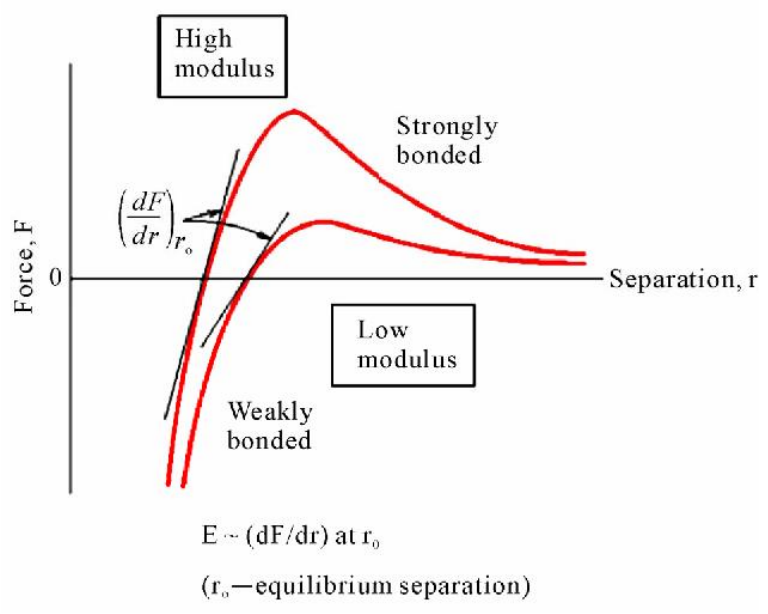
Ionic bonding

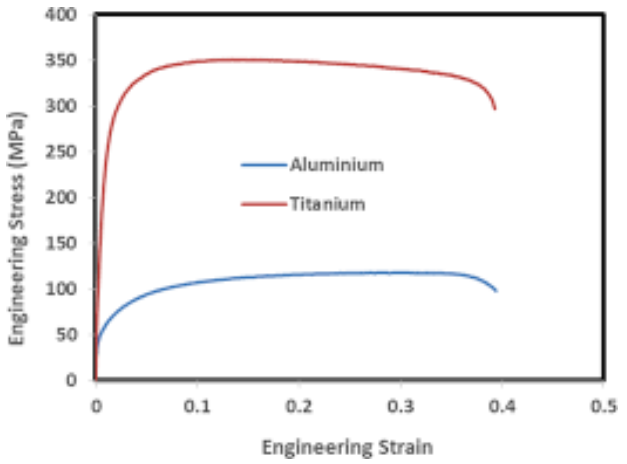
Van der waals' bonding



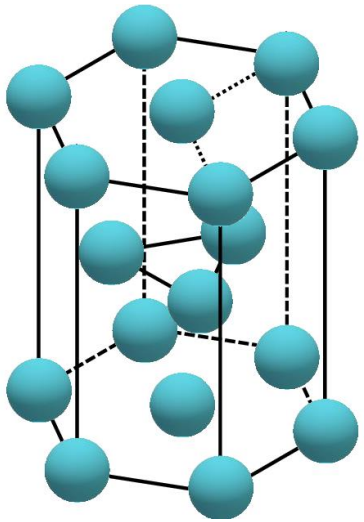
Does every material with metallic bonding exhibit similar properties?

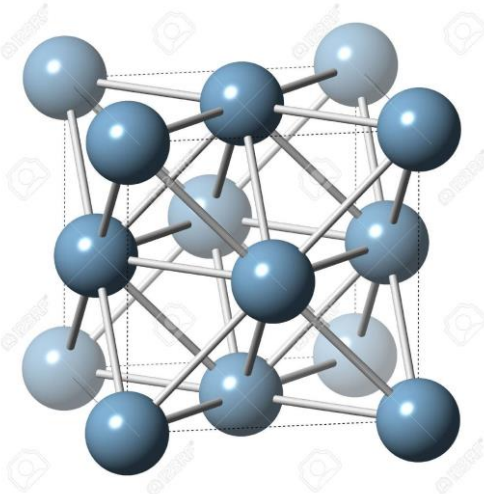






Structure

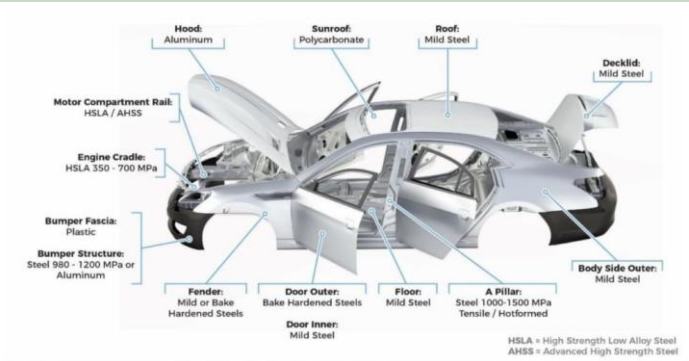




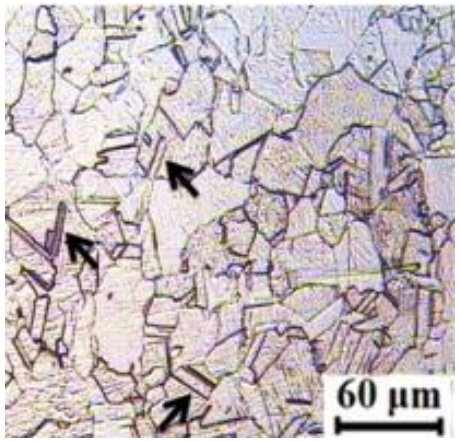
Structure of materials

What do you mean by ‘Structure’?

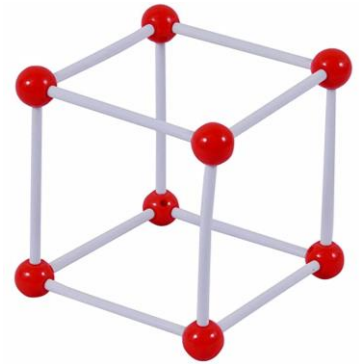
Quantitative description of arrangement of internal constituents in a material at different length scales



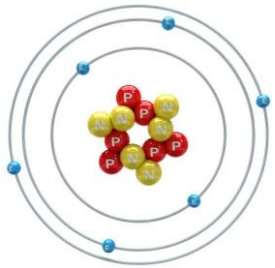
Macro-structure (> cm)



Micro-structure (µm)



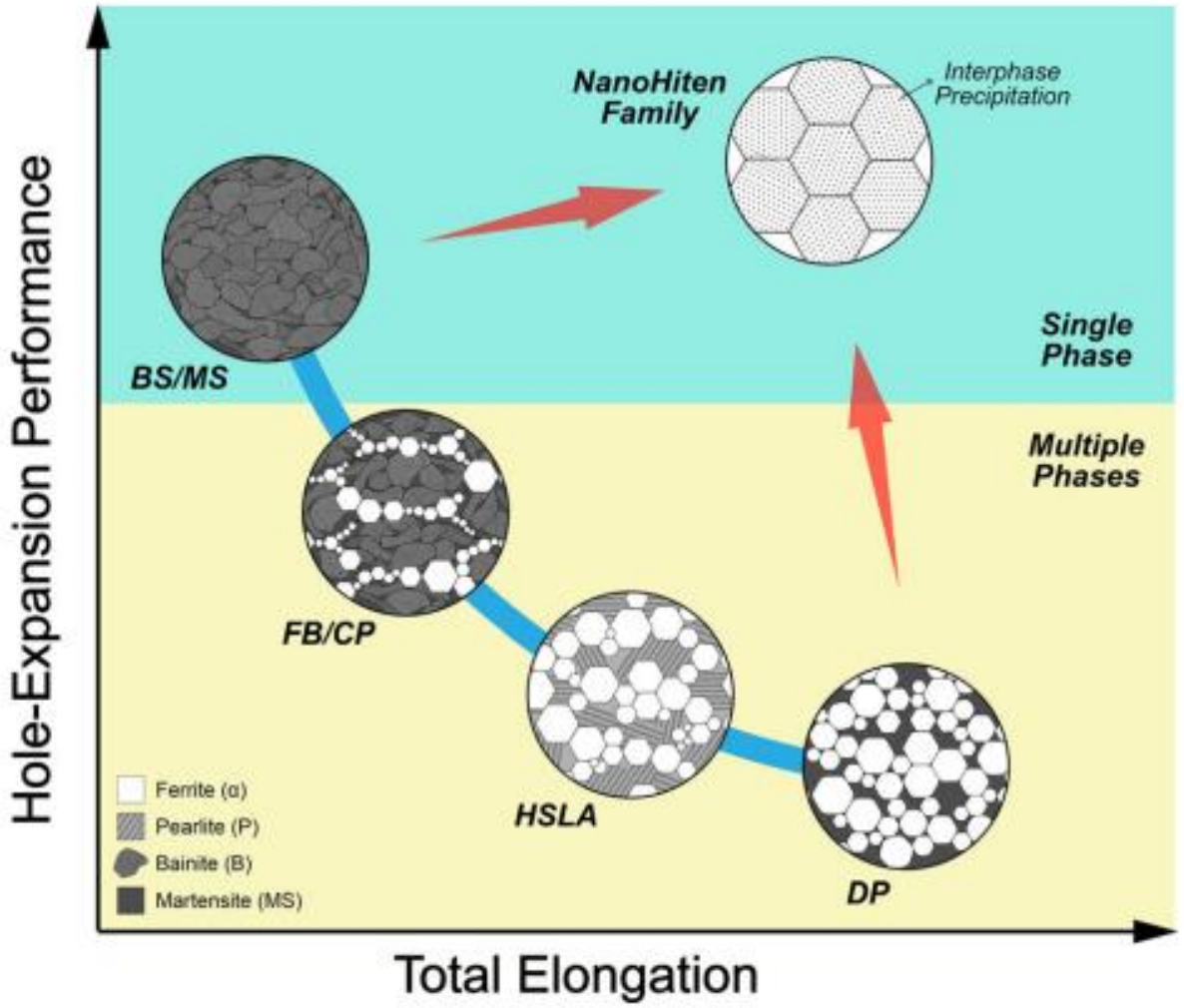
Crystal structure (Å)



Atomic structure (pm)

Length scale

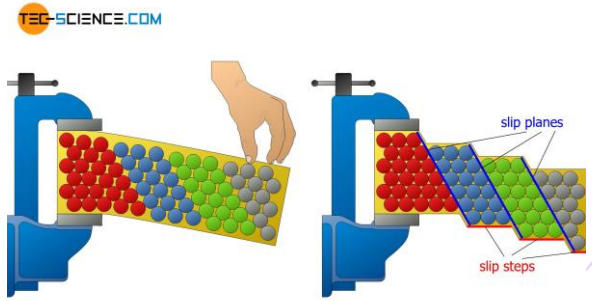
Can a single material exhibit different properties?

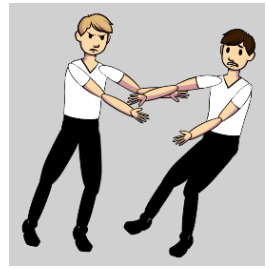


---------- YES!

By carrying out different processing.

Structure of materials across different length scales to assess their **performance** and to control materials **properties** through **processing**.





Structure

What structure would impart the desired combination of properties?

Properties

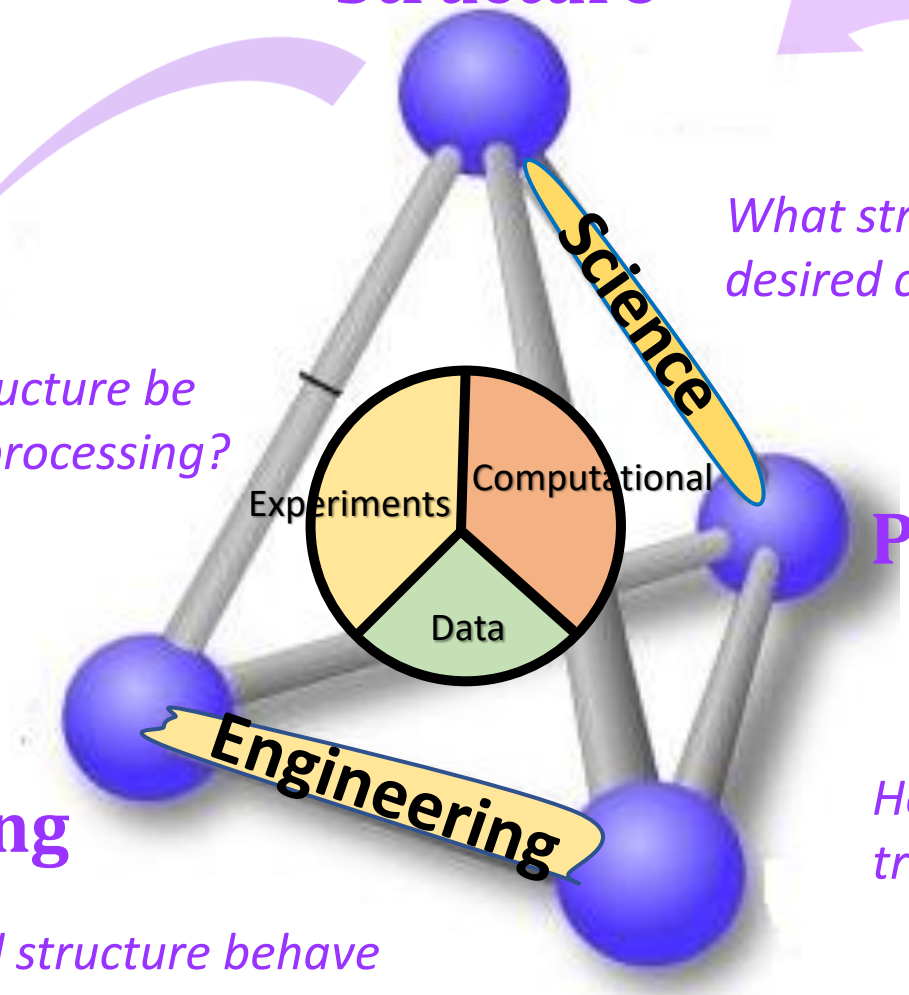
How performance could be translated to desired properties?

Performance

How does the achieved structure behave during service impacting efficiency, durability?

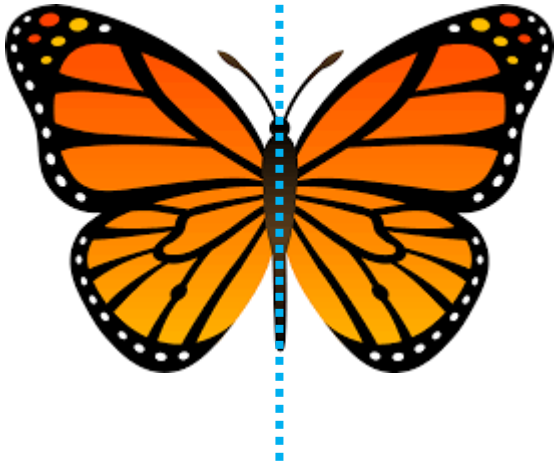
Processing

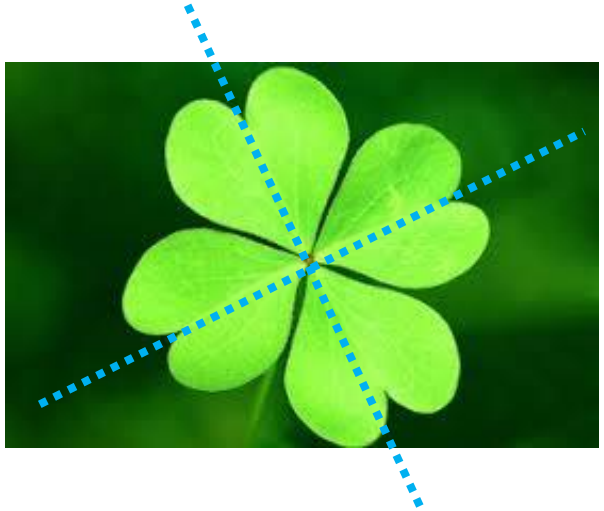
How can a structure be achieved via processing?

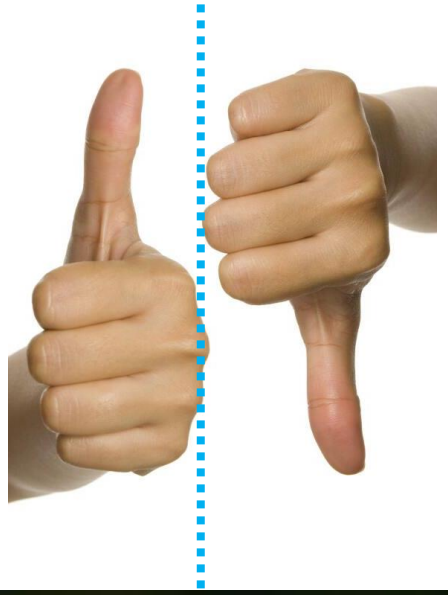


What are the factors which allow us to study crystal structure?

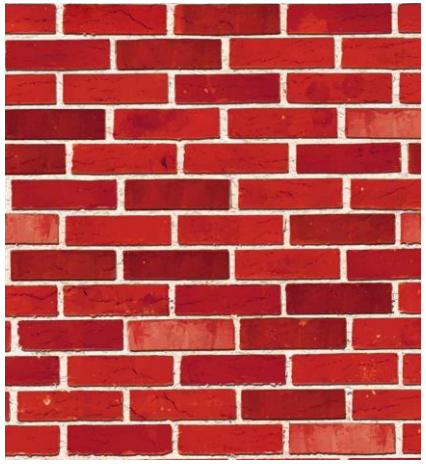
Symmetricity







Periodicity



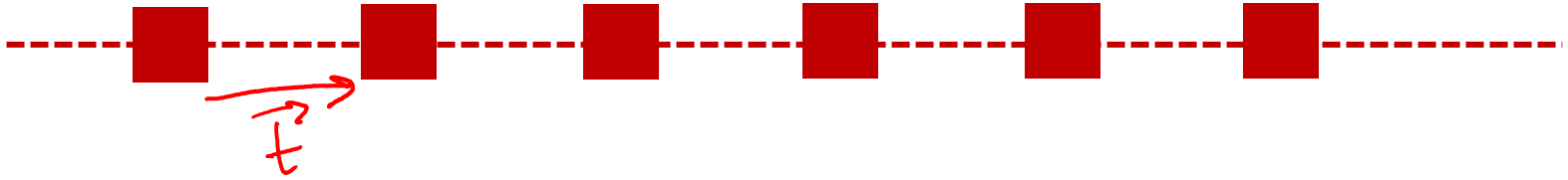
Brick patterns in wall

Honeycomb

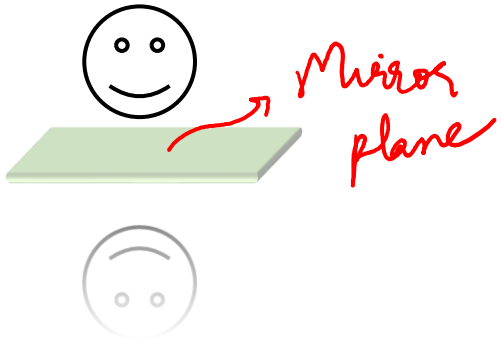
- Inversion
- Rotation
- Mirror
- Translation
- Glide

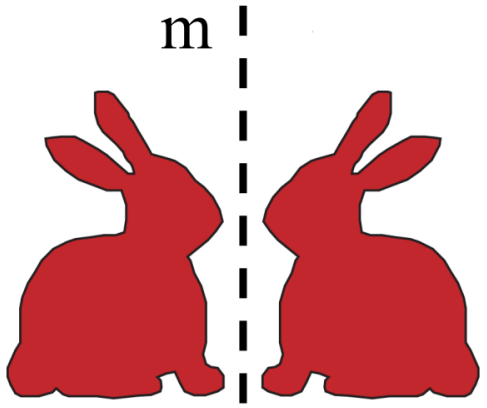
Symmetry

Translational



Reflectional





Rotational

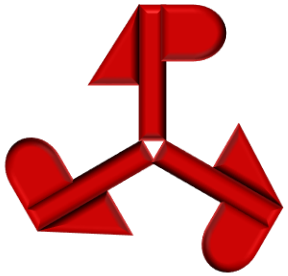
$$n - fold = \frac{360^\circ}{n}$$

$1 - fold = \frac{360^\circ}{1}$ $2 - fold = \frac{360^\circ}{2}$ $3 - fold = \frac{360^\circ}{3}$ $4 - fold = \frac{360^\circ}{4}$ $6 - fold = \frac{360^\circ}{6}$

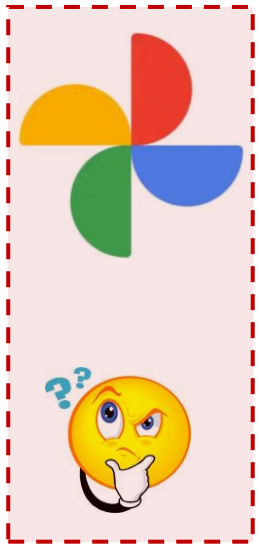
1-fold

2-fold

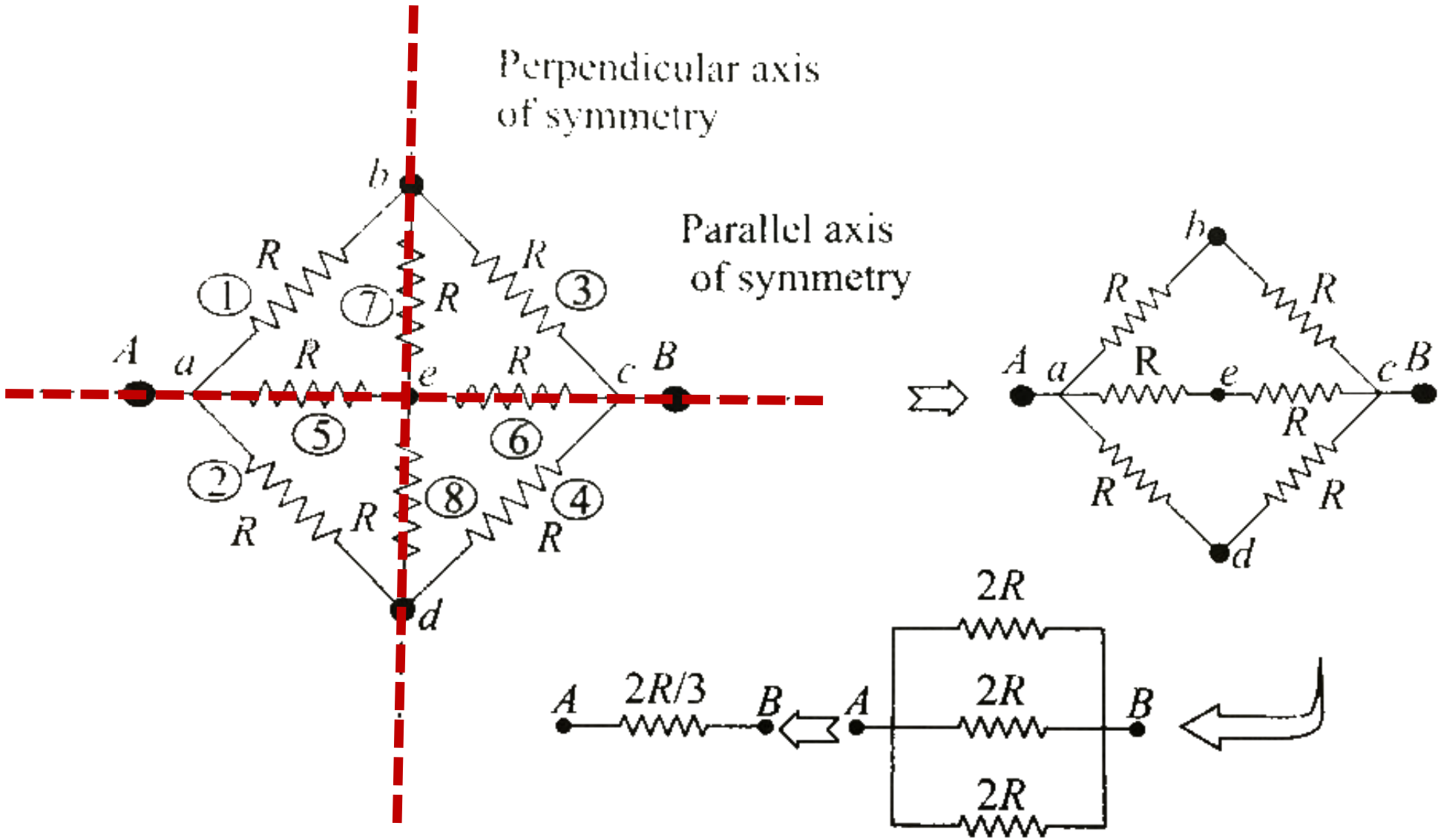
3-fold



4-fold

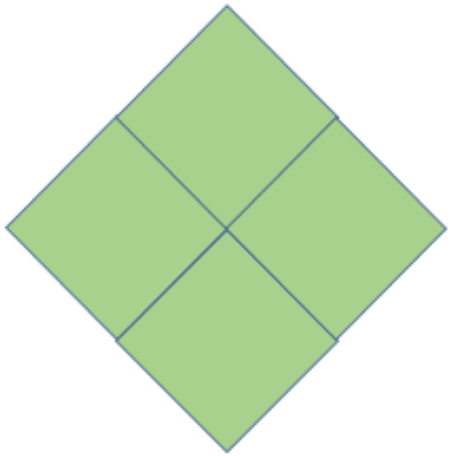


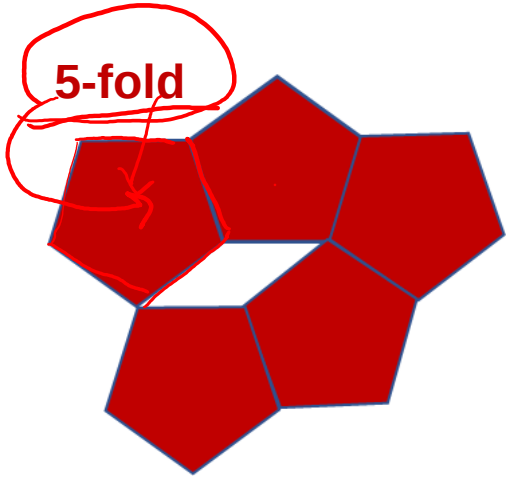
6-fold

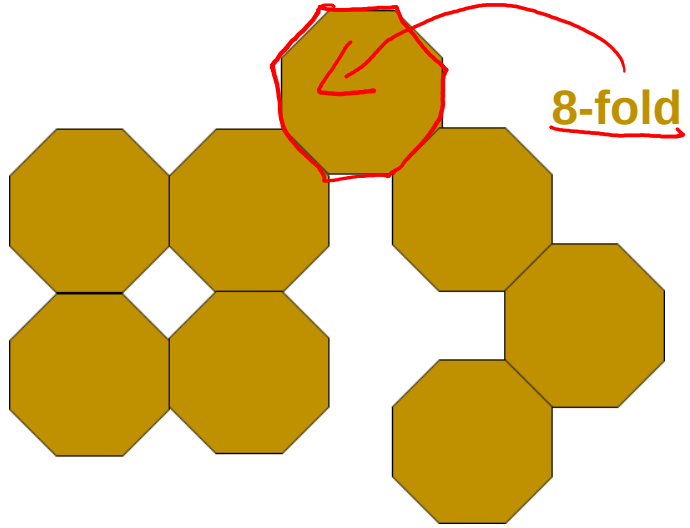

Perpendicular axis
of symmetry
Parallel axis
of symmetry
b
R
R
1
7
R
3
A
a
R
e
R
c
B
5
6
2
8
4
R
R
R
R
d
b
R
R
A
a
R
e
c
B
R
R
R
d
2R
A
2R/3
B
A
2R
B
2R

Why no mention of 5-fold rotational symmetry?

4-fold







Translational symmetry absent in long range