Concluding/summarizing

Wrapping up …

To summarize/sum up/conclude …

Inviting questions

Please don't hesitate to interrupt my talk when questions occur.

I'd like to thank you for your attention.

I'll be happy/pleased to answer questions now.

Dealing with questions

I cannot answer this question right now, but I'll check and get back to you.

Perhaps this question can be answered by again referring to/looking at table …

1.6 Case Study: The Turbofan Aero Engine

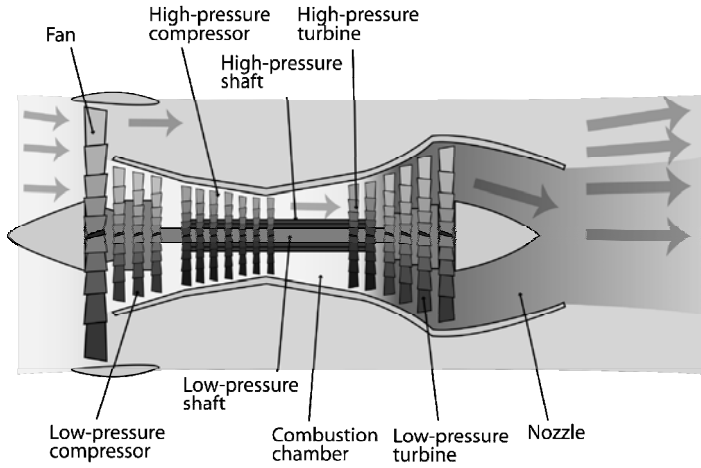

Figure 2: Cross-section of a turbofan aero engine [wikipedia]

Task 1. *Work with a partner. Study the following notes. Then refer to* 1.5 Phrases for Academic Presentation *and give a short presentation about the subject.*

In the turbofan aero engine, which is used to power large planes, air is propelled past and into the engine by the turbofan, providing aerodynamic *thrust*. The air is further compressed by compressor blades, then mixed with fuel and burnt in the *combustion* chamber. The expanding gases drive the turbine blades, which provide power to the turbofan and the compressor blades, and finally pass out of the rear of the engine, adding to the thrust.

Two kinds of materials were considered:

Metal, a titanium *alloy*

material's properties and in-service requirements:

Young's Modulus, *yield strength*, *fracture toughness* sufficiently good

high *density* (the heavier the engine, the less payload can be carried)

resistance to *fatigue* (due to rapidly varying loads)

resistance to surface wear (striking water drops, large birds)

resistance to corrosion (salt sprays from ocean entering the engine)

Composite, carbon-fiber reinforced polymer (CFRP)

material's properties and in-service requirements:

low density (half of that of titanium)

low weight

low toughness (potential deformation of blade by bird strike)

The problem posed by choosing CFRP for a blade can be overcome by cladding, which means giving the CFRP a metallic leading edge.

(from Ashby/Jones, modified and abridged)

Glossary

thrust	a forward directed force
combustion	the process of burning; here of fuel
alloy	a metallic substance that is composed of two or more elements which keep the same crystal structure in the alloy
Young's Modulus	elastic modulus (E), a material's property that relates *strain* (ε, epsilon) to applied *stress* (σ, sigma)
strain	the response of a material when *tensile stress* is applied
tensile stress	a force tending to tear a material apart
stress, *n*	the force applied to a material per unit area; (σ, sigma = F/A or lb/*in*²)
in	inch, 2.54 cm
yield strength	the point at which a material starts to deform permanently
fracture toughness	the measure of a material's resistance to fracture when a *crack* occurs
crack, *n*, *v*	a break, fissure on a surface
density	mass per volume
fatigue	the weakening/failure of a material resulting from prolonged stress

1.7 Some Abbreviations for Academic Purposes

Task 1. *Add your notes in the column on the right.*

AC	alternating current	
approx., ca.	approximate(ly)	
AT	air temperature	
at. no.	atomic number	
at. wt.	atomic weight	
avg.	average	
b.p.	boiling point	
c., cu., cub.	cubic	
cath.	cathode	
cc	cubic centimetre(s)	
cf. (conferre)	confer, compare	
C. of C.	coefficient of correlation	
co.	column	
cont(d).	continue(d), contain(ed)	
ctr.	center	
DC	direct current	
Dept.	department	
dup.	duplicate	
e.g. (exempli gratia)	for example	
esp.	especially	
est(d).	estimated	
etc. (et cetera)	and so on	
ex.	example	
f., ft.	foot, feet, frequency	
hor.	horizontal	
i.e. (id est)	that is	
in., ins.	inch(es)	

incl.	including, included, inclusive	
kWh	kilowatt-hour(s)	
l., ll.	long, length, line, lines	
liq.	liquid	
max., min.	maximum, minimum	
mech.	mechanical	
misc.	miscellaneous	
mol wt.	molecular weight	
m.p.	melting point	
n.a.	not applicable	
NB, nb (nota bene)	note particularly	
No., no.	number	
ord.	ordinary, ordinal	
oz(s).	ounce(s)	
par.	parallel	
prev.	previous	
pt.	part	
qt.	quantity, quart	
resp.	respectively	
rpm	revolutions per minute	
stat.	statistics	
std.	standard	
syn.	synthetic	
tech.	technical(ly)	
vel.	velocity	
vs.	versus	
w/	with	
w/o	without	
yd(s).	yard(s)	

Chapter 2 Characteristics of Materials

2.1 Structure

The structure of a material is usually determined by the arrangement of its internal components. On an atomic level, structure includes the organization of atoms relative to one another. Subatomic structure involves electrons within individual atoms and interactions with their nuclei. Some of the important properties of solid materials depend on geometrical atomic arrangements as well as on the interactions that exist among atoms or molecules.

Various types of primary and secondary interatomic bonds hold together the atoms composing a solid.

The next larger structural area is of nanoscopic scale which comprises molecules formed by the bonding of atoms, and particles or structures formed by atomic or molecular organisation, all within 1 *nm* – 100 nm dimensions. Beyond nano scale are structures called microscopic, meaning that they can directly be observed using some kind of microscope. Finally, structural elements that may be viewed with the naked eye are called macroscopic.

(from Callister, modified and abridged)

Glossary

nm	nanometer (10^{-9} m)

Task 1. *Work with a partner. Fill in the table with the different structural levels and their characteristics as described in the text.*

structural level	characteristics

I. Eisenbach, *English for Materials Science and Engineering,* DOI 10.1007/978-3-8348-9955-2_2,

Task 2. *Choose the correct terms for the following definitions.*

A sufficiently stable, electrically neutral group of at least two units in a definite arrangement held together by strong chemical bonds. .....

The smallest particle characterizing an element .....

A fundamental subatomic particle, carrying a negative electric charge. .....

It makes up almost all the mass of an atom. .....

A positively charged subatomic particle. .....

An electrically neutral subatomic particle. .....

2.2 Some Phrases for Academic Writing

Introduction

In this paper/project/article we will focus on …
In our study, we have investigated …
Our primary objective is …

Making a generalization

It is well known that …
It is generally accepted that …

Making a precise statement

In particular
Particularly/especially/mainly/ more specifically

Quoting

According to/referring to …
As has been reported in … by …
Referring to earlier work of …

Introducing an example

e.g. …
if … is considered for example

Interpreting

The data could be interpreted in the following way …

These data infer that …

This points to the fact that …

Referring to data

As is shown in the table/chart/data/diagram/graph/plot/figure

Adding aspects

Furthermore our data show …

In addition … has to be considered

Expressing certainty

It is clear/obvious/certain/noticeable that …

An unequivocal result is that …

Expressing uncertainty

It is not yet clear whether …

However it is still uncertain/open if …

Emphasizing

It has to be emphasized/stressed that …

Summarizing

Our investigation has shown that …

To summarize/sum up our results …

Concluding

We come to the conclusion that …

Our further work will focus on …

Further studies/research on … will still be needed.

Detailed insights into … are still missing.

2.3 Case Study: The Gecko

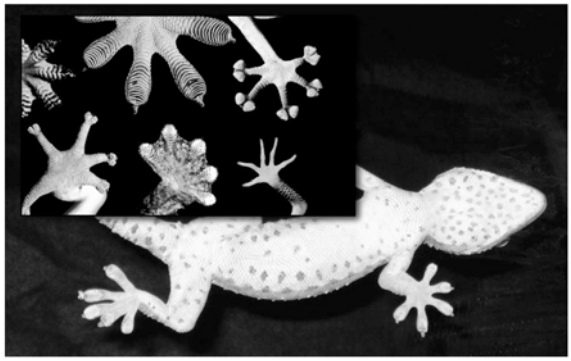

Figure 3: The underside of a gecko and its feet [adapted from Seshadri]

Task 1. *Work with a partner. Fill the gaps in the text with words from the box in their correct form. Some terms are used more than once.*

adhesion; *adhesive;* design; horizontal; mass; microscopic; molecule; *release; residue;* self-cleaning; sticky; surface; underside; vertical

The photograph shows the ..... of a gecko, a harmless tropical lizard, and its toes. Researchers worldwide are studying the animal's adhesive system. The scientists want to learn from nature how to ..... dry adhesives such as geckos apply when moving their feet over smooth surfaces. The animals achieve high adhesion and friction forces required for rapid ..... (running up walls) and inverted (running along the underside of ..... surfaces) motion, since their ..... feet will cling to virtually any surface. Yet they can easily and quickly release the sticky pads under their toes to make the next step. A gecko can support its body ..... with a single toe, because it has an extremely large number of ..... small ordered fiber bundles on each *toe pad*. When these fibrous structures come in contact with a surface, weak forces of attraction, i.e. van der Waals forces, are established between hair ..... and molecules on the surface. The fact that these fibers are so small and so numerous explains why the animal grips ..... so tightly. To ..... its grip, the gecko simply curls up its toes and peels the fibers away

from the surface. Another fascinating feature of gecko toe pads is that they are ..... that is, dirt particles don't stick to them. Scientists are just beginning to understand the mechanism of ..... for these tiny fibers, which may lead to the development of ..... self-cleaning synthetics. Imagine *duct tape* that never looses its stickiness or bandages that never leave a sticky .....

(from Callister, modified and abridged)

Glossary

adhesive *n*, *adj*, to adhere, adhesion, *n*	a substance used for joining surfaces together, sticky
release, *v*, *n*	to let go
residue	the remainder of sth after removing a part
toe pad	a cushion-like flesh on the underside of animals' toes and feet
duct tape	an adhesive tape for sealing heating and air-conditioning ducts

2.4 Property

While in use, all materials are exposed to external stimuli that cause some kind of response. A property is a material characteristic that describes the kind and magnitude of response to a specific stimulus. For example, a specimen exposed to forces will experience deformation, or a metal surface that has been polished will reflect light. In general, definitions of property are made independent of material shape and size.

Virtually all important properties of solid materials may be grouped into six different categories:

- mechanical
- electrical
- thermal (including melting and *glass transition temperatures*)
- magnetic
- optical
- deteriorative

(from Callister, modified and abridged)

Glossary

glass transition temperature T_g	the temperature at which, upon cooling, a non-crystalline ceramic transforms from a supercooled liquid to a solid glass
supercooled	cooled to below a phase transition temperature without the occurrence of transformation

Mechanical Properties relate deformation to an applied load or force; examples include *elastic modulus* and strength.

Glossary

elastic modulus (E)	or Young's Modulus, a material's property that relates strain (ε, epsilon) to applied stress (σ, sigma), cf. p. 9

Electrical Properties are, e.g. electrical *conductivity*, *resistivity* and *dielectric constant*. The stimulus is voltage or an electric field.

Glossary

conductivity	ability to transmit heat and/or electricity
resistivity	a material's ability to oppose the flow of an electric current
dielectric constant	a measure of a material's ability to resist the formation of an electric field within it

Thermal Properties of solids can be described by heat capacity and thermal conductivity.

Poor thermal conductivity is responsible for the fact that space shuttle *tiles* containing amorphous, porous silica (SiO_2) can be held at the corners, even when glowing at 1000 °C.

Glossary

tile	a flat, square piece of material

Task 1. *Work with a partner. Refer to the texts, then answer the questions.*

What is a material's property?

.....

Do mechanical properties deal with deformation?

.....

How can the thermal behavior of solids be characterized?

.....

Magnetic Properties demonstrate a material's response to the application of a magnetic field.

Optical Properties are a material's response to electromagnetic or visible light. The index of *refraction* and *reflectivity* are representative optical properties.

Glossary

refraction	the bending of a light beam upon passing from one medium into another
reflectivity	the ability to reflect, i.e. to change the direction of a light beam at the interface between two media

Deteriorative Properties relate to the chemical reactivity of materials. The chemical reactivity, e.g. corrosion, of a material such as an alloy, can be reduced by heat treating the alloy prior to exposure in salt water. Heat treatment changes the inner structure of the alloy. Thus crack propagation leading to mechanical failure can be delayed.

Glossary

propagation	the process of spreading to a larger area

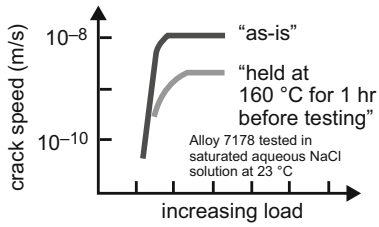

Figure 4:
Crack propagation and load [adapted from Seshadri]

Task 2. *Refer to 2.5* Some Phrases for Describing Figures, Diagrams and Reading Formulas *and write a short paragraph for the plot in the figure above, describing what is shown.*

The graph in the figure above shows

.....

.....

.....

.....

.....

.....

.....

2.5 Some Phrases for Describing Figures, Diagrams and for Reading Formulas

Graph/Diagram

the graph/diagram/figure represents …

it shows a value for …

it shows the relationship between …

the curve shows a steep *slope*, a peak, a trough

the curve rises steeply/flattens out/drops/extrapolates to zero

Plot

to plot points on/along an axis

to plot/make a plot … versus … for …

x is plotted as a function of y

Coordinate System

abscissa (x-axis) and ordinate (y-axis)

the coordinate system shows the frequency of … in relation to/per …

Angle

parallel; perpendicular; horizontal to

right angle (90°)

acute angle (smaller than 90°)

obtuse angle (larger than 90°)

straight angle (180°)

Mathematics

to apply a law

to equal, to be equal to

to calculate/compute

to determine/assume/substitute a value

to *derive* an equation

in a fraction, there are numerator and divisor (denominator)

Glossary

slope	a line that moves away from horizontal
to derive	to deduce; to obtain (a function) by differentiation

Task 1. *Complete the table.*

10,000	is read ten thousand
0.28	is read …
$^1/_4$	
$^1/_{12}$	one over twelve
$6\ ^3/_5$	
x^2	
x^3	
x^{-4}	
$\sqrt{4}$	
$\sqrt[3]{a}$	
$1/x$	
a_n	
$^n a$	

Glossary

slope	a line that moves away from horizontal
to derive	to deduce; to obtain (a function) by differentiation

2.6 Grammar: Comparison

Comparing Two or more Things in English

Add **-er** and **–est** to adjectives with one syllable

strong – stronger – strongest

to adjectives with two syllables and ending with **-y**

oily – oilier – oiliest

Use **more** and **most** for adjectives with more than two syllables and not ending with -y

resistant – more resistant – most resistant.

for adverbs

Polyethylene is more frequently produced than poly(tetrafluoro ethylene).