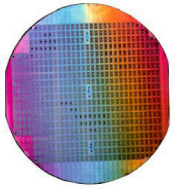
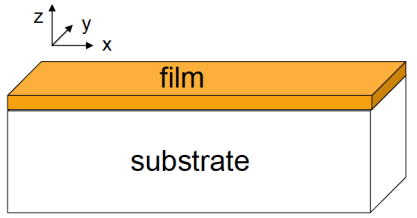
Thin Films
CHEM-E5125
Introduction to course

Jari Koskinen

Terminology

- Film or coating is material which is restricted in one dimension
- Substrate is solid material supporting the film
- Thickness
  - Atomic level:
    - 2 – 5 atom layers on the surface (≈ 0.2 – 0.5 nm)
    - over 10 atomic layers (≈ 1 nm) is bulk
  - Technically
    - 1nm – 10 µm
    - Needed layer thickness, which is needed to:
      - protect substrate
      - Wanted functionality of the coating





Terminology

- Continous / discontinous island structure
  - discontinous
  - network film (partially continous)
  - continous

- Thick films or thick coatings
  - several µm to mm range
    - Protection to high mechanical loading
    - Simple means to deposit
      - melts
      - welding
      - powder /paste
      - etc.

Film growth

chemical reaction on surface

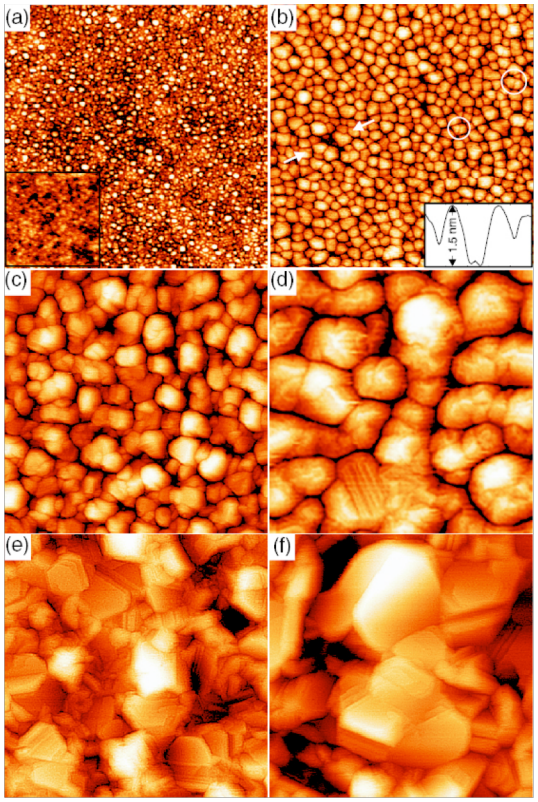
plasma discharge with ions

decomposition of a compound

reaction of a gas or liquid with substrate surface

physical process

evaporation or sputtering from solid target followed by condensation



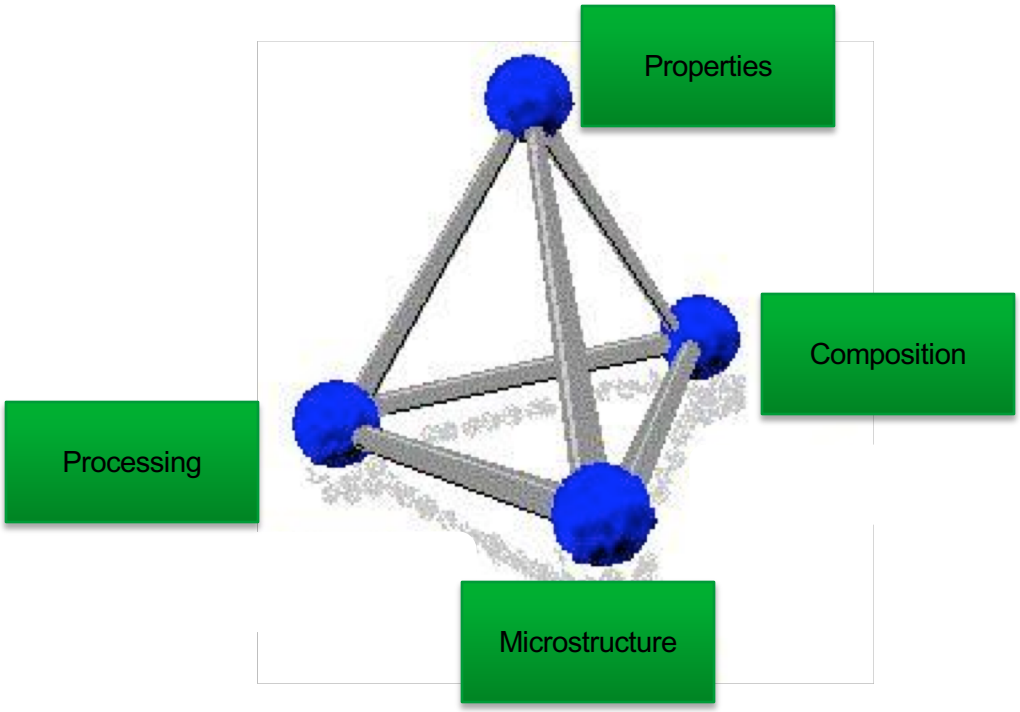
http://ej.iop.org/images/1367-2630/9/3/074/Full/nj236996fig2.jpg

Motivations - why thin films?

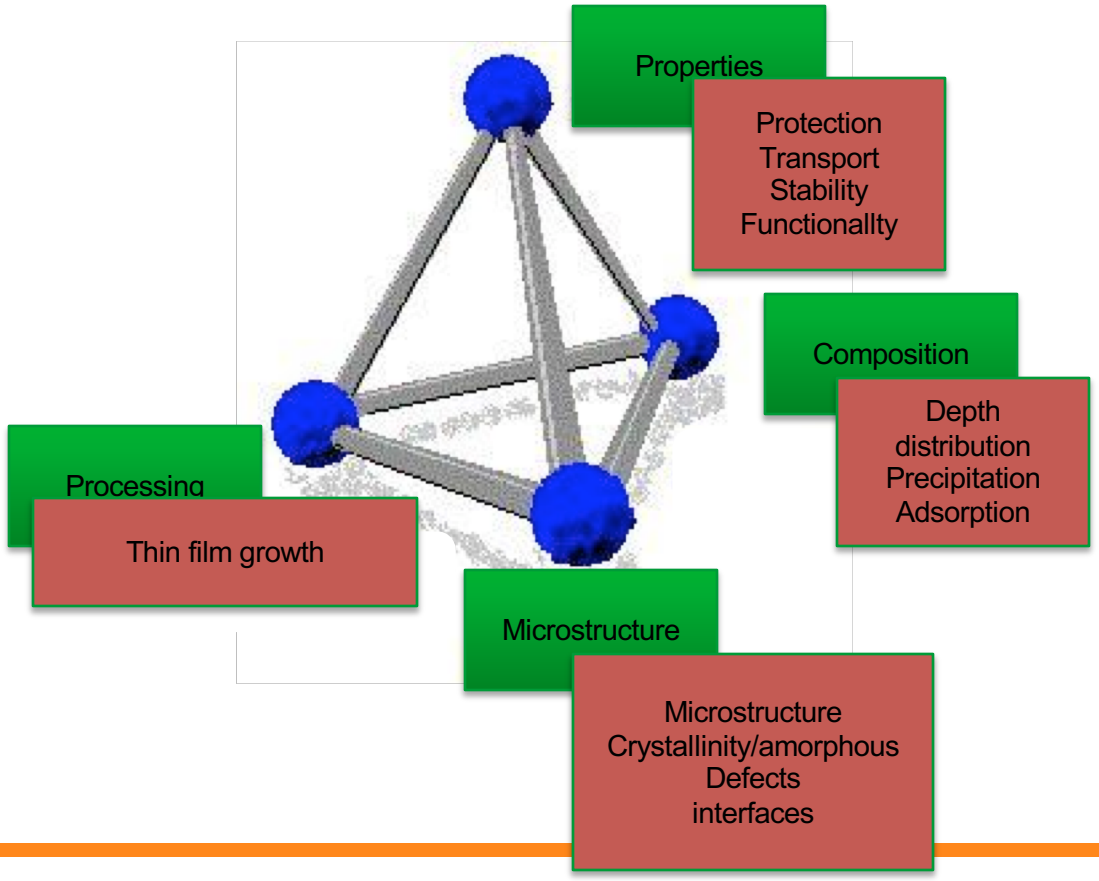
- Interaction of solid material with surrounding often through surface
- Modification of material properties
- REACH directives to reduce risks of chemicals in industry
- Market of thin films and coatings
  - volume about 25 G€ in UK 2005
    - about 1% of GNP
  - Volume of Photovoltaic, optical, semiconductors, MEMS etc. about 10 G$ 2018

  - common in all areas of industry
    - electronics
    - transport
    - energy
    - building

Materials Science tetra



Materials Science and Thin Films tetra



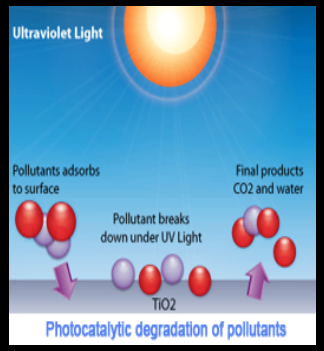
Hardness, protection and wear

Diamond-like carbon

Art & Decoration

Titanium Nitride,
Titanium Dioxide

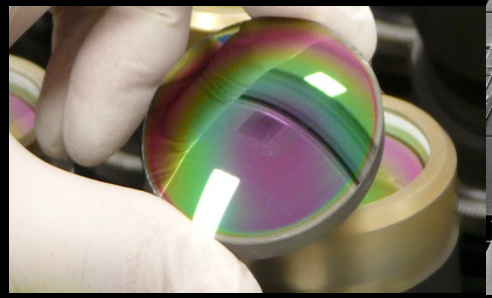
Function and utility

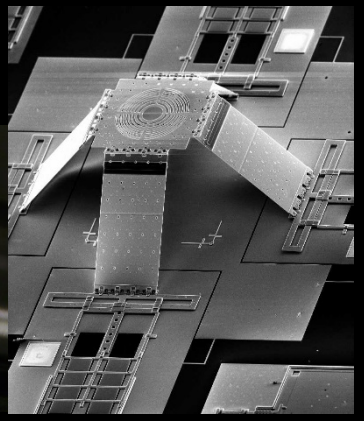


Titanium Dioxide: Photocatalytic activity

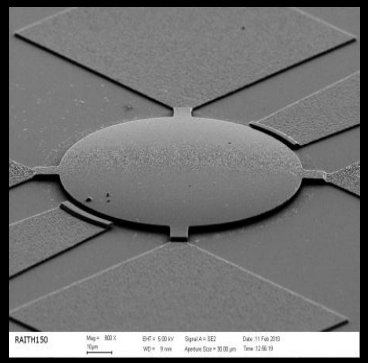
Indium Tin Oxide, ITO: Defrosting coating

Optical systems, optical MEMS





Microelectromechanical systems, MEMS



Applications of thin films

- Electronic components
  - semiconducting, dielectric, insulating, conductors, barriers…
- Electronic displays
  - LCrystalD, LED, ELuminescent, Echorimc, transparent conductive…
- Photo voltaic
- Optical coatings
- Magnetic Films for Data Storage
- Optical data storage
- Antistatic coatings
- Hard protective coatings

- Decorative films
- Decorative and wear-resistant (decorative/functional) coatings
- Permeation barriers for moisture and gases
- Corrosion resistant films
- Coating of engine turbine blades
- Wear and erosion resistant (hard) coatings (tool coatings)
- Dry film lubricants
- Thin-walled freestanding structures
- Many more available

Coating technologies

Handbook of Deposition Technologies for Films and Coatings - Science, Applications and Technology (3rd Edition)
Edited by: Martin, Peter M. © 2010 William Andrew Publishing

Table 1.1: Vacuum deposition techniques [10]

Atomistic deposition	Particulate deposition	Bulk coatings	Surface modification
Electrolytic environment	Thermal spraying	Wet processes	Chemical conversion
Electroplating	Plasma spraying	Painting	Electrolytic
Electroless plating	D-gun	Dip coating	Anodization (oxide)
Fused salt electrolysis	Flame spraying	Electrostatic spraying	Fused salts
Chemical displacement	Fusion coatings	Printing	Chemical–liquid
Vacuum environment	Thick film ink	Spin coating	Chemical vapor
Vacuum evaporation	Screen printing	Cladding	Thermal
Ion beam deposition	Jet printing	Explosive	Plasma
Laser ablation	Enameling	Roll bonding	Leaching
Molecular beam epitaxy	Electrophoretic	Overlaying	Mechanical
Cathodic arc	Impact plating	Weld coating	Shot peaning
Vacuum polymer deposition			Thermal
Plasma environment			Surface enrichment
Sputter deposition			Diffusion from bulk
Activated reactive evaporation			Sputtering
Cathodic arc			Ion implantation
Plasma polymerization			Self-assembly
Ion plating			
Chemical vapor environment			
Plasma enhanced			
Atomic layer deposition			
Reduction			
Decomposition			
Spray pyrolysis			
Liquid phase epitaxy			

Coating technologies in this course

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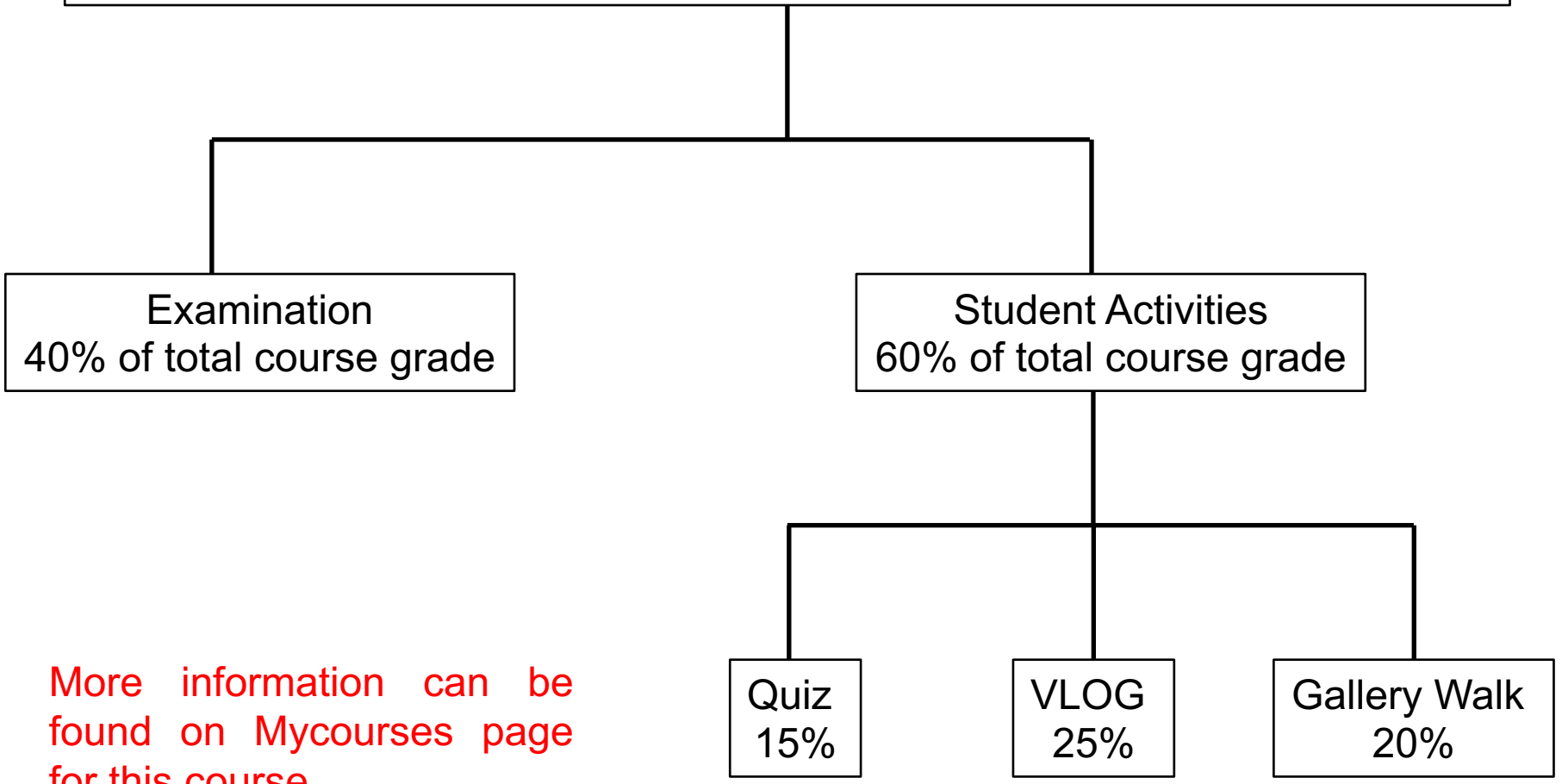
Decomposition			
Spray pyrolysis			
Liquid phase epitaxy			

COURSE FRAMEWORK

Date	Time	Place	Lecture Schedule
9/01/2019	08.00 – 10.00	Ke5 D311	Introduction & Demo **(DO NOT MISS)** / Jari Koskinen
11/01/2019	12.00 – 14.00	D311	Q1, Vacuum and surface engineering/ Jari Koskinen
16/01/2019	08.00 – 10.00	D311	Q2, PVD 1 / Jari Koskinen
18/01/2019	12.00 – 14.00	D311	Q3, PVD 2 / Jari Koskinen
23/01/2019	08.00 – 10.00	D311	Q4, Characterisation / Jari Koskinen
25/01/2019	12.00 – 14.00	D311	Application 1 discussion / Jari Koskinen
30/01/2019	08.00 – 10.00	D311	Q5, CVD and ALD / Sami Franssila
1/02/2019	12.00 – 14.00	D311	Application 1 Students Walking Gallery
6/02/2019	08.00 – 10.00	D311	Q6, Other thin films/ Sami Franssila
8/02/2019	12.00 – 14.00	D311	Application 2 discussion / Jari Koskinen
13/02/2019	08.00 – 10.00	D311	Application 2 Students Walking Gallery
15/02/2019	12.00 – 14.00	D311	5 best VLOG presentations
22/02/2019	09.00 – 13.00	A305	Exam 1
x/x/2019	0x.00 – 1x.00	X	Exam 2

E5125 Thin Film Technology 2019, 5cr.



More information can be found on Mycourses page for this course.

Lectures

- Lecture slides will be uploaded in advance.
- Students are expected to read lecture slides and refer to other reading material (See Mycourses) prior to the lecture.
- There will be a short and easy quiz before lecture to test your understanding.
- It is expected that students have the electronic version of the lecture slides and clarify any doubts and queries during the lecture. Please be interactive.
- Lecture will focus on important aspects for that topic.
- Course is divided into 2 main parts:
  - Theoretical aspect of thin films with lectures and quizzes
  - Practical aspect with discussion of application fields and gallery walk.

Video Log (VLOG)

- All students are expected to prepare a 10 minute VLOG.
- The VLOG is based on both theoretical and practical aspect of the course.
- The VLOG topic is common for all and can be found on Mycourses with detailed instructions for making the VLOG.
  - Thin film process – select one for your VLOG
  - The VLOG is to be used as an educational 10 min lecture for master student of Thin Films
  - Deadline 11.2.2019
  - See rules in Mycourses

Walking Gallery

- Here students will work in a group.
- Each group will have an application related article to study.
- There will be common fixed questions for which answers will have to be found.
- It is expected that the students widen the scope and study similar articles by themselves in order to answer the questions.
- On the day of walking gallery the group will get together and have 30 minutes to make their “posters”.
- At the end of this period the students re-shuffle and study each others “posters” and ask relevent questions.
- More information on Mycourses