

A scanning electron micrograph (SEM) showing a dense array of vertical nanowires. The nanowires have a textured, slightly irregular surface. In the center, there is a smaller, more detailed inset image showing a close-up of the nanowire structure, highlighting their helical or twisted morphology. A scale bar in the bottom left corner indicates 1 μm.

Thorsten Staedler

Materials Science and Engineering

Winter term 2006/2007

Lecture:

Monday,
8.30-10.00,
room PB H/0103

Exercise:

Monday,
10.30-12.00,
room PB H/0103

1 μm

Organization of the Course

Lecture:

2 hours per week – ppt slides + blackboard

Exercise:

2 hours per week – questions and problems
to be solved in the group

Examination:

project work + presentation (small groups) approx. 30%
written exam (2 hours) at the end of the term (February) approx. 70%

Textbook:

W.D. Callister, Materials Science and Engineering.
An Introduction, Wiley 2003 (library: 85 ZLI 2053)

Questions & Problems/project work (Studienarbeit):

Dr. T. Staedler, PB H002/e-mail: thorsten.staedler@uni-siegen.de

Presentations

small groups (3 people)

subject has to be subdivided

preliminary discussion (November)

approx. 6 pages paper (template will be available)

20 minutes presentations (+10min discussion, end of term)

subjects:

Biomaterials

Micro-electro-mechanical systems MEMS

Nanostructures/Nanocomposites

Wear protection of cutting tools

Objective of the Course

- provide basics in materials physics to understand the material behavior, i.e. microstructural changes, during application
- enable students to select appropriated materials from different classes for given applications
- enable students to apply suitable material testing and characterization procedures to support the engineering design process

Content 1st lecture

1 Introduction to materials science
and materials engineering

2 Atomic Structure of Materials

Historic Development



stone age (100000 B.C.)

natural materials

stone
wood
ceramics
copper

tools, weapons

bronze age (3000 B.C.)

empirical development

bronze
glass
iron

iron age (1500 B.C.)

middle ages (1500 AD)

cast iron

ground
transportation/
industrialization
aerospace

modern times (20th century)

quantitative development

Al alloys (1930)
polymers (1940)

modern times (21th century)

nanoengineered materials

semiconductors
(1955)

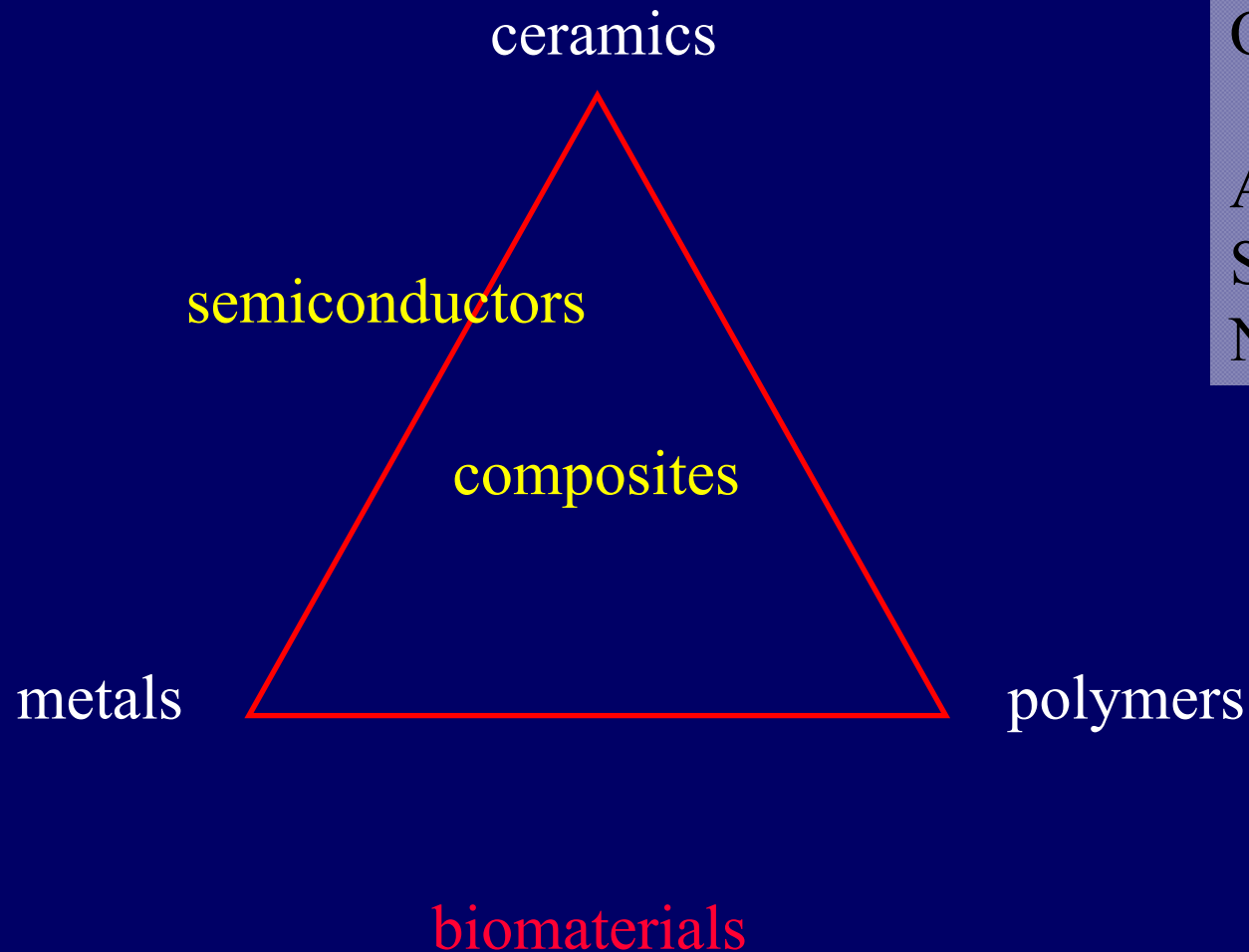
information
technology

Materials science and engineering



linear interrelationship

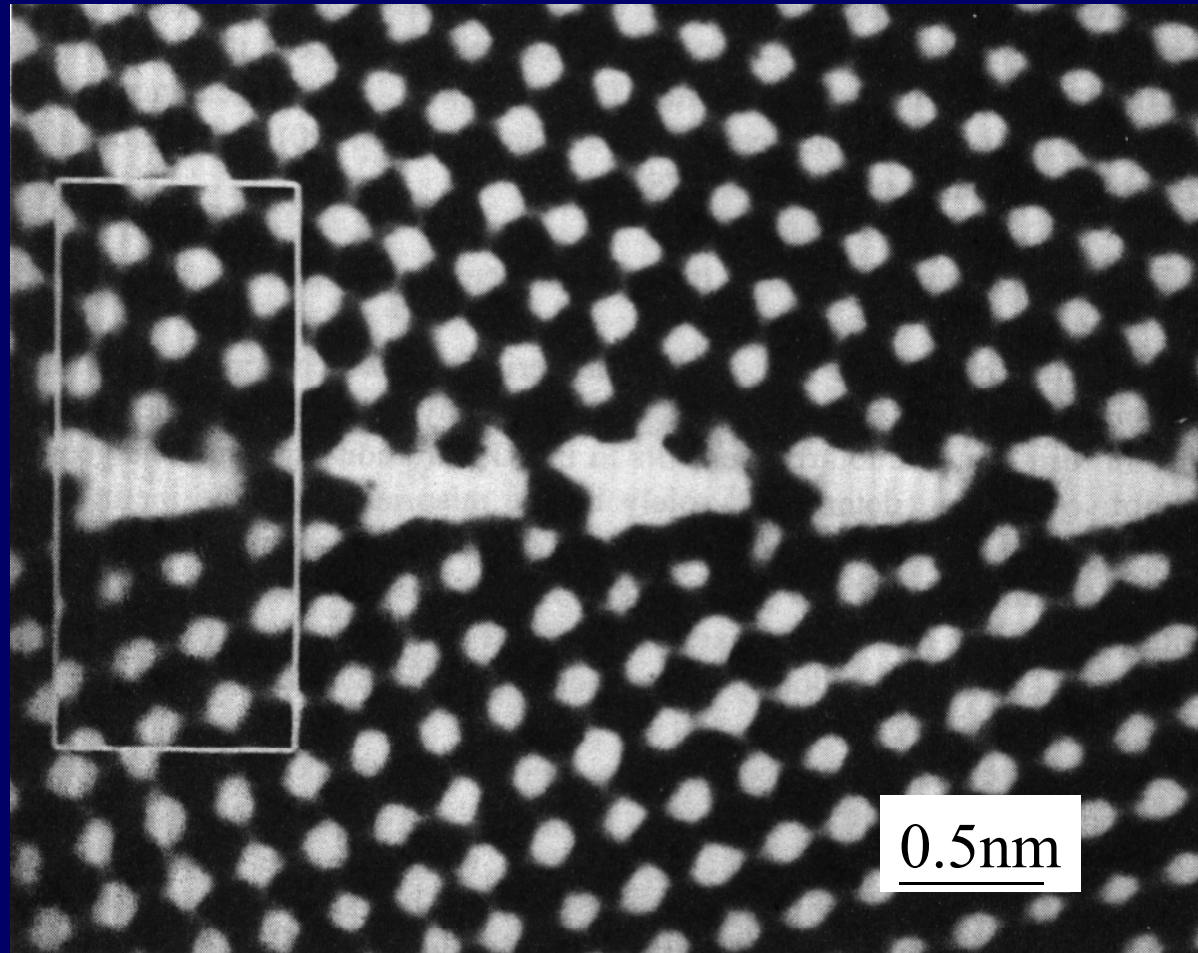
Materials classification



Other terms:

Advanced materials
Smart materials
Nanotechnology

2 Atomic Structure of Materials



High-Resolution TEM micrograph

Atomic Models

Niels Bohr:

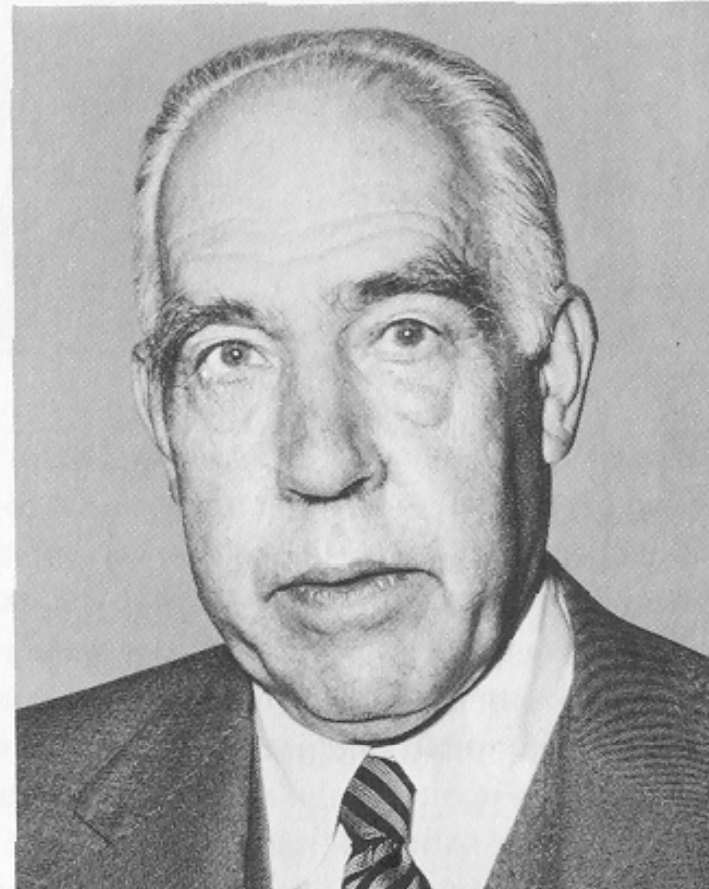
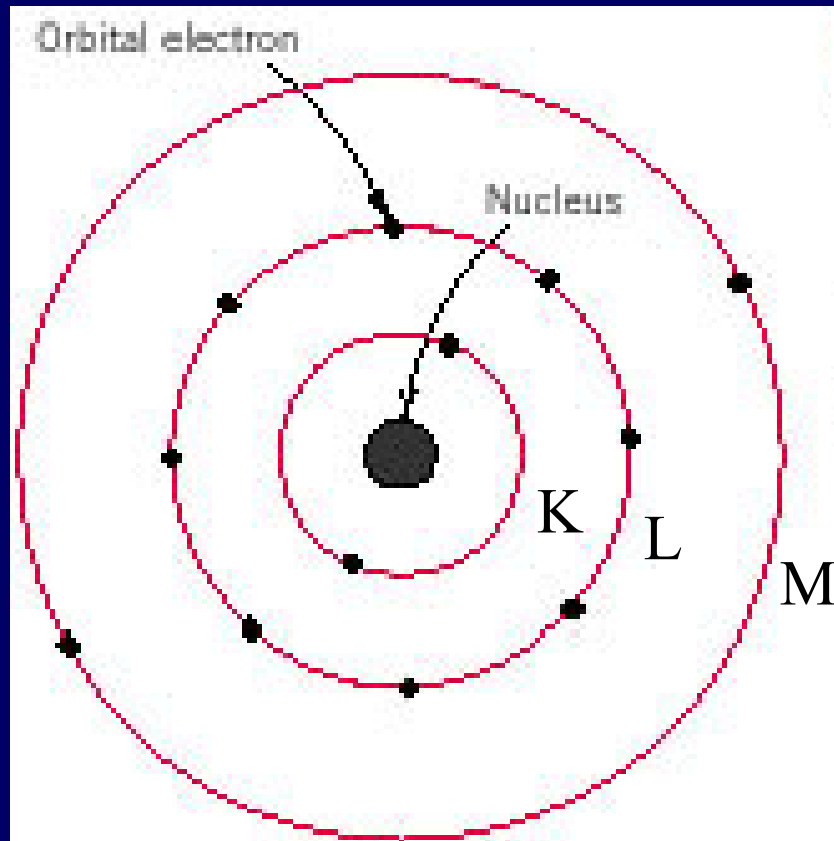


Abb. 2.19. N. Bohr

Pauli principle:

each electron state can hold no more than two electrons of opposite spin

Wave mechanical model

An electron is characterized by 4 parameters, so called quantum numbers

Principle quantum number n (1, 2, 3, ...)

Second quantum number l (subshell) (s, p, d, or f)

Third quantum number m_l (energy states in a given subshell)

$l=s \rightarrow 1$ state, $=p \rightarrow 3$ states, $=d \rightarrow 5$ states, $=f \rightarrow 7$ states

Spin moment m_s – each state may have two spin orientations

Example of an electron configuration: Sodium (ground state)



The Periodic Table

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

increasing electronegativity

METALS

INTERMEDIATE

NONMETALS

Break

Next lecture will cover

- Bonding in solids
- Structure of crystal solids

