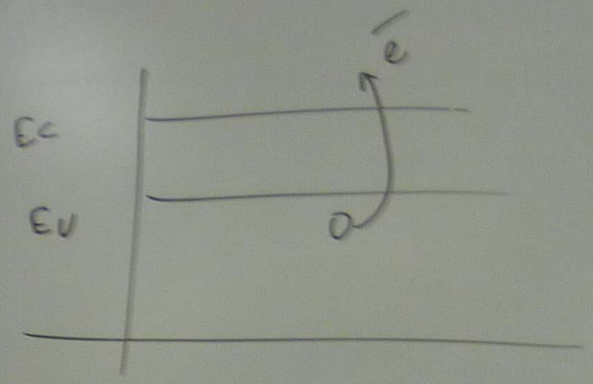
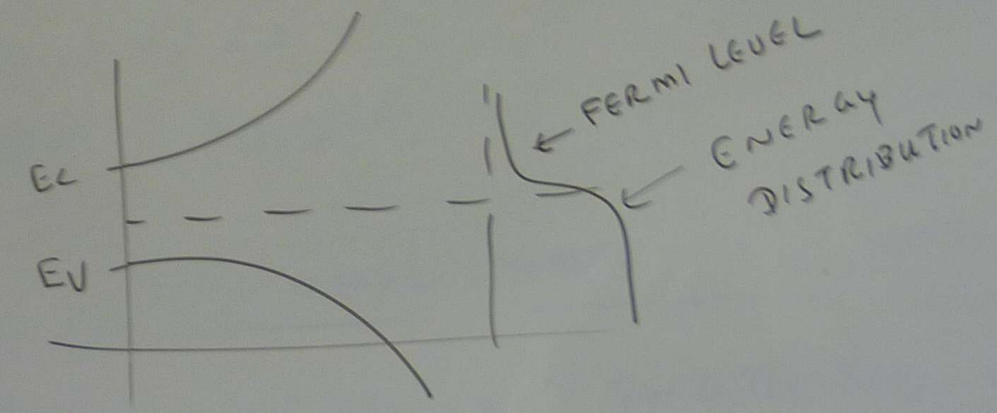


E_V = ENERGY BALANCE LEVEL

E_c = CONDUCTION LEVEL ENERGY



Ec, EV CURVE DEPENDS ON KIND of MATERIALS.

FERMAL LEVEL — TH

E_1 = ENERGY STA

E_2 = ENERGY S

E_F = FERM ENE

P(E) = P-

N(E) = N-

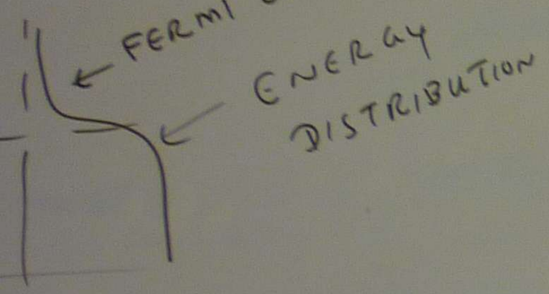
INSULATORS

CONDUCTORS

SEMI CONDU

ANCE LEVEL

IEL ENERGY



EPENDS ON KIND of

FERMAL LEVEL — THE LEVEL OF ENERGY EXERTED ON ELECTRON FOR MOVEMENT.

E_1 = ENERGY STATE 1

E_2 = ENERGY STATE 2

E_F = FERMI LEVEL ENERGY $= \frac{E_1 + E_2}{2}$

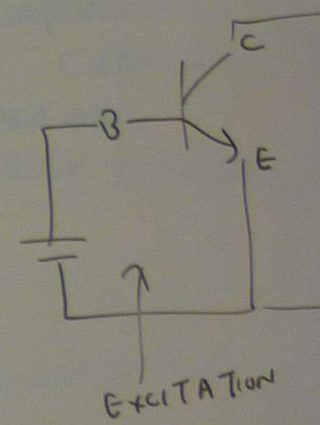
P(E) = P-TYPE SEMI CONDUCTOR MATERIAL ENERGY

N(E) = N-TYPE SEMI CONDUCTOR MATERIAL ENERGY

INSULATORS - RESISTIVITY MORE THAN 10^8 Ω-cm
GLASS, MICA

CONDUCTORS - RESISTIVITY LESS THAN 10^{-3} Ω-cm

SEMI CONDUCTOR - Ge / Si



TRANSISTOR IS
PASSAGE OF E
IS DETERMINE
WHICH ACTS
AND POSITIVE

– THE LEVEL OF ENERGY EXERTED ON
ELECTRON FOR MOVEMENT.

ay STATE 1

ay STATE 2

FERMI LEVEL ENERGY $= \frac{E_1 + E_2}{2}$

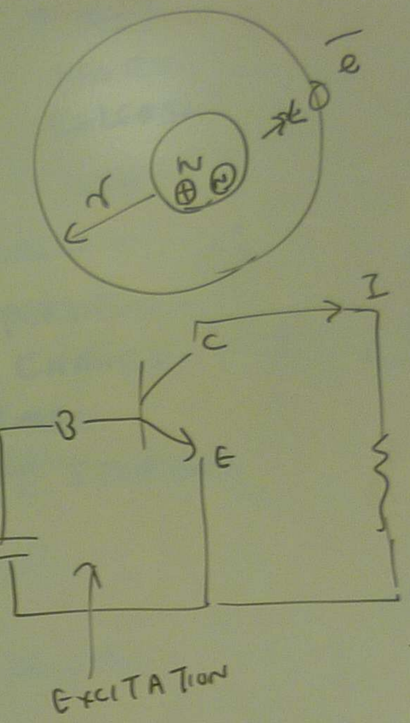
P – TYPE SEMI CONDUCTOR MATERIAL
ENERGY

N – TYPE SEMI CONDUCTOR MATERIAL
ENERGY

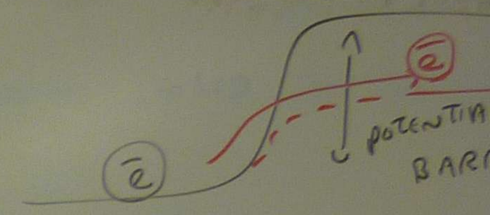
TORS – RESISTIVITY MORE THAN $10^8 \Omega$-cm
GLASS, MICA

TORS – RESISTIVITY LESS THAN $10^{-3} \Omega$-cm

ONDUCTOR – Ge / Si



TRANSISTOR IS SOLID STATE DEVICE
PASSAGE OF ELECTRICAL CURRENT
IS DETERMINED BY BINDING FORCE
WHICH ACTS BETWEEN ELECTRON
AND POSITIVELY CHARGED NUCLEUS

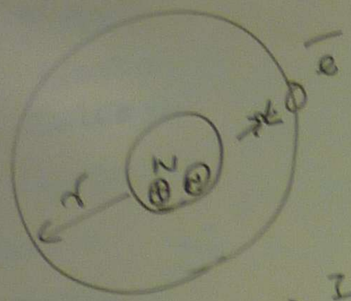


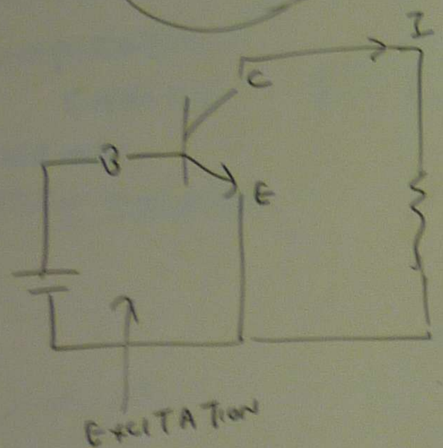
SEMI CONDUCTO

$$\frac{e^2}{4\pi\varepsilon_0 r^2} = \frac{mv^2}{r}$$

e = ELECTRON CHA
m = MASS OF ELE
V = VELOCITY OF

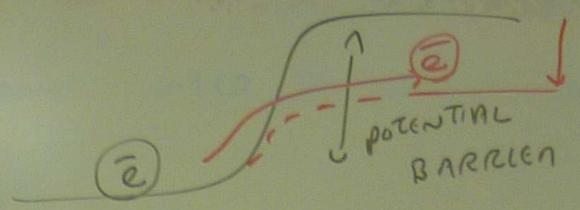
THIS EQUATION
OF ELECTRON, m





EXCITATION

TRANSISTOR IS SOLID STATE DEVICE
PASSAGE OF ELECTRICAL CURRENT
IS DETERMINED BY BINDING FORCE
WHICH ACTS BETWEEN ELECTRON
AND POSITIVELY CHARGED NUCLEUS



REDUCTION OF POTENTIAL BARRIER BY FIELD EXCITATION

SEMI CONDUCTORS

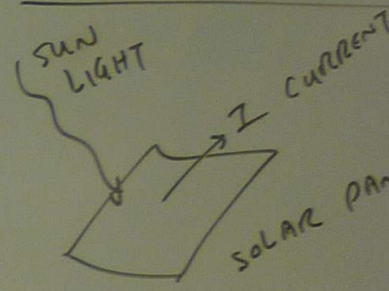
$$\frac{e^2}{4\pi\epsilon_0 r^2} = \frac{m v^2}{r}$$

e = ELECTRON CHARGE
m = MASS OF ELECTRON
V = VELOCITY OF ELECTRON

r = RADIUS ORBIT
ϵ_0 = PERMITIVITY
π = 3.1416

THIS EQUATION DESCRIBES THE CHARGE OF ELECTRON, MASS, VELOCITY.

BOHR'S THEORY of



ALL ENERGY IS
THE form of
QUANTUM

ENERGY IN EACH
QUANTUM

REDUCTION OF POTENTIAL BARRIER BY FIELD EXCITATION

POTENTIAL BARRIER

UCTORS

$\frac{mv^2}{r}$

CHARGE

ELECTRON

OF ELECTRON

r = RADIUS ORBIT

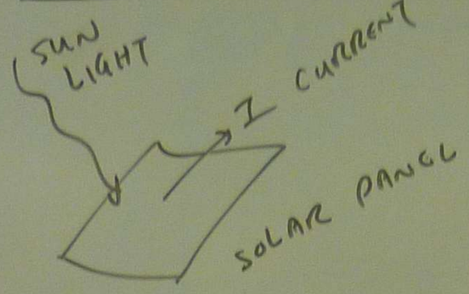
ϵ_0 = PERMITIVITY

$\pi = 3.1416$

N DESCRIBES THE CHARGE

, MASS, VELOCITY.

BOHR'S THEORY of HYDROGEN ATOM



ALL ENERGY IS EMITTED AND ABSORBED IN THE FORM of MULTIPLES OF UNIT IS CALLED QUANTUM

ENERGY IN EACH QUANTUM

$E = h\nu$

h = PLANK CONSTANT 6.62×10^{-34} J-sec

ν = FREQUENCY of RADIATION (Hz)

IONIZED EN

IT IS

MOVING

CHE

BI

+

$2H_2$ -

IONIZED ENERGY $E = E_c - E_v = h\nu$

IT IS PHOTON RADIATION → ABSORBED ELECTRO-MAGNETIC ENERGY

MOVING ELECTRON POSSESSES KINETIC ENERGY AND POTENTIAL ENERGY

$$KE = \frac{1}{2} mv^2 = \frac{e^2}{8\pi \epsilon_0 r}$$

$$PE = \frac{-e^2}{4\pi \epsilon_0 r}$$

E_n = MOVING ELECTRON ENERGY $= KE + PE = \frac{e^2}{8\pi \epsilon_0 r} - \frac{e^2}{4\pi \epsilon_0 r}$

$$= -\frac{e^2}{8\pi \epsilon_0 r}$$

CHEMICAL BINDING — BALANCE VALANCE AND ATOMIC

$$2H_2 + O_2 = 2H_2O$$

POSITIVE VALANCE AND NEGATIVE COMBINES → COMBINATION APPROACHES THE CHEMICAL STABILITY.

6.62×10^{-34} J-sec

RADIATION (Hz)

ELECT

THE ENE

THE

032

033

034

035

037

CTRO-MAGNETIC

AND POTENTIAL
ENERGY

$$\frac{e^2}{\epsilon_0 r} - \frac{e^2}{4\pi\epsilon_0 r}$$

$$- \frac{e^2}{8\pi\epsilon_0 r}$$

ANCE AND NEGATIVE

→ COMBINATION
APPROACHES THE
CHEMICAL STABILITY.

ELECTRON ENERGY LEVELS

THE ENERGY LEVELS of INNER SHELL ARE HIGHER THAN THE OUT SHELLS.

TUTORIAL

Q32 DESCRIBE TRANSISTOR

Q33 DESCRIBE BOHR'S THEORY of HYDROGEN ATOM

Q34 WRITE THE EQUATION FOR PHOTON RADIATION

Q35 HOW DOES CHEMICAL STABILITY ACHIEVE?

Q37 EXPLAIN CHEMICAL AND ATOMIC STRUCTURE OF INSULATOR AND CONDUCTOR.

Q32 TRANSISTOR IS SOLID STATE DEVICE. PASSAGE OF CURRENT IS DETERMINED BY THE BINDING FORCE WHICH ACTS BETWEEN ELECTRON AND POSITIVELY CHARGED ATOM NUCLEUS.

Q33 BOHR'S THEORY

ALL ENERGY IS EMITTED AND ABSORBED IN THE FORM of MULTIPLES OF UNIT CALLED QUANTUM.

ENERGY IN EACH QUANTUM $E = h\nu$

ν = FREQUENCY OF RADIATION

h = PLANK CONSTANT 6.62×10^{-34} J/s

CURRENT IS

N ELECTRON

HE FORM OF

FREQUENCY OF

RADIATION

LANK CONSTANT

6.62×10^{-34} J/s

034

PHOTON RADIATION ACTS

IONIZED ENERGY = ENERGY DIFFERENCE

BETWEEN $n=1$ AND $n=\infty$

$$E = E_\infty - E_1 = \frac{m e^4}{8 h^2 E_0^2}$$

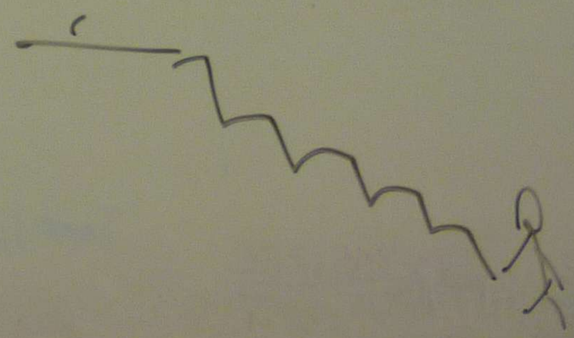
035 CHEMICAL STABILITY

WHEN POSITIVE CHARGES AND NEGATIVE CHARGES COMBINE, THE COMBINATIONS APPROACHES CHEMICAL STABILITY.

$$H_2SO_4 + KOH = K_2SO_4 + H_2O$$

↑ ACID ↑ BASE

NEUTRALIZED.



037 INSULA

CONDUCTO

FORBIDD

eV

VALAN

AT ROOM

IS EMPTY

- THERE IS
CAN GAIN
FORBIDDE

CONDUCTOR

- OUTER
TO PAR

WHEN ELECTRO
ENERGY, IT
CURREN

DIFFERENCE

$n=1$ AND $n=\infty$

$$E_\infty - E_1 = \frac{m e^4}{8 h^2 E_0^2}$$

TY

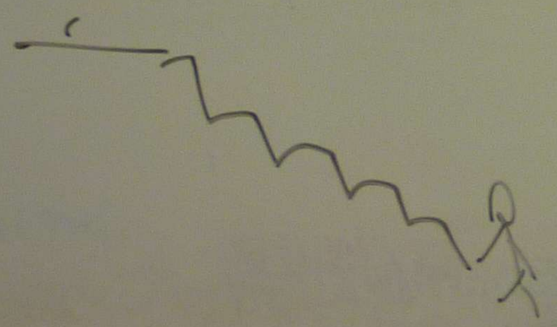
AND NEGATIVE CHARGES COMBINE, THE

CHEMICAL STABILITY.

$= \quad K_2SO_4 + H_2O$

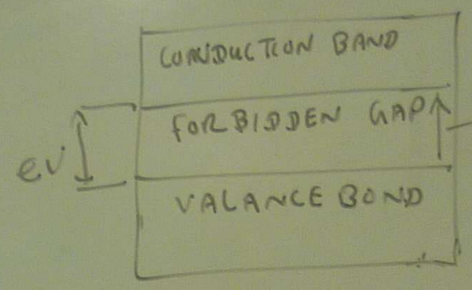
$\longleftrightarrow$

NEUTRALIZED.



237

INSULATOR



AT ROOM TEMPERATURE, CONDUCTION BAND IS EMPTY. FORBIDDEN GAP $>$ 1 eV

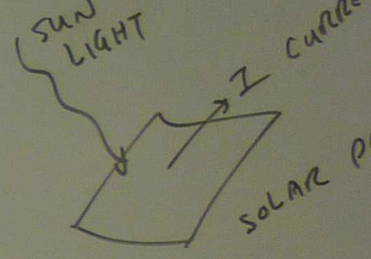
- THERE IS NO ELECTRON IN MATERIAL WHICH CAN GAIN ENOUGH ENERGY TO CROSS THE FORBIDDEN GAP

CONDUCTOR

- OUTER ELECTRONS ARE LOOSELY BOUND TO PARENT NUCLEUS

WHEN ELECTRON GAINS THE SMALL AMOUNT OF ENERGY, IT CAN MOVE AND ELECTRIC CURRENT FLOWS.

BOHR'S THEORY of



ALL ENERGY

THE FORM of

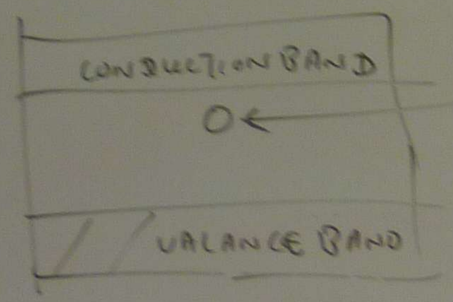
QUANTUM

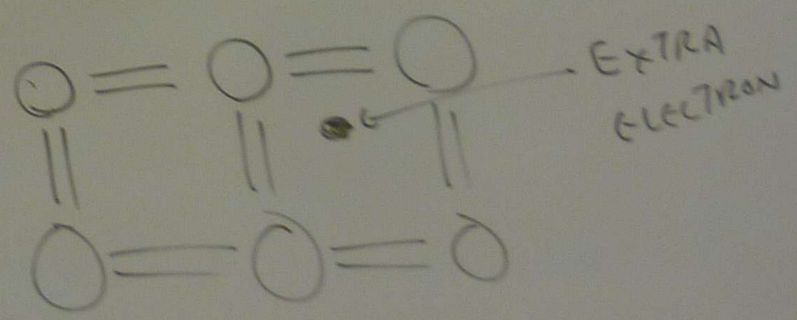
ENERGY IN EACH

QUANTUM

P AND N TYPE SEMI CONDUCTORS

- IMPURITIES EFFECT THE CONDUCTIVITY
- ELECTRON AND POSITIVE HOLE MOTION MAKE TO TOTAL CONDUCTIVITY





$E_m^1 = -$

$8m^2$

n = NO. OF PAT

m = MASS OF A

e = CHARGE OF

q_0 = INITIAL STA

q_n = CHARGE

h = PLANK

E_m^1 = ENER

CONDUCTION

OF FREE

$V = \mu$

$$E_n^1 = \frac{-me^4}{8n^2h^2\varepsilon_0^2 q_r^2}$$

n = NO. OF PATH

m = MASS OF ATOM

e = CHARGE OF ELECTRON

ε_0 = INITIAL STATE CHARGE

q_r = CHARGE AT r^{th} STATE

h = PLANK CONSTANT

E_n^1 = ENERGY

- EXTRA ELECTRON

CONDUCTION DEPENDS ON MOBILITY OF FREE ELECTRONS.

$$V = \mu\delta$$

V = DRIFT VELOCITY $cm\,s^{-1}$

δ = FIELD STRENGTH

μ = MOBILITY $cm^2\,V^{-1}\,sec^{-1}$

$$\delta = \delta_n + \delta_p$$

δ_n = N-TYPE SEMI CONDUCTOR FIELD STRENGTH

δ_p = P-TYPE SEMI CONDUCTOR FIELD STRENGTH

$$\delta = e(n_i\mu_n + n_i\mu_p)$$

$p = n = n_i$

μ_p = MOBILITY OF 'P' TYPE SEMI CONDUCTOR

μ_n = MOBILITY OF 'N' TYPE SEMI CONDUCTOR

GENER

BECAUSE
AT ROOM
BEING
GENERAT
- ELECTRO
TO PRO

VAL

IT IS
HOLE

GENERATION & RECOMBINATION

BECAUSE of VIBRATIONAL ENERGY of CRYSTAL LATTICE AT ROOM TEMPERATURE, COVALENT BONDS ARE CONTINUALLY BEING BROKEN. THIS PROCESS IS ELECTRON-HOLE PAIR GENERATION.

- ELECTRONS ARE BEING RECAPTURED BY UNFILLED BONDS TO PRODUCE THE RECOMBINATION OF $\bar{e}$ - HOLE PAIRS.

VALANCE

IT IS SETUP BETWEEN GENERATION AND RECOMBINATION HOLES AND ELECTRON DENSITY ⟶ THERMAL EQUILIBRIUM.

DENSITY of STATES IN ENERGY BAND

THE PASSAGE of ELECTRON FROM TOP of VALANCE BAND TO BOTTOM of CONDUCTION BAND REQUIRES THE EXPENDITURE OF LEAST AMOUNT OF ENERGY.

TAL LATTICE
CONTINUALLY
- HOLE PAIR
FILLED BONDS
POLE PAIRS.

RECOMBINATION
RMAL
ULIBRIUM.
ND
M TOP OF
UCTION
OF

NUMBER OF ELECTRONS MOVING BETWEEN TWO BANDS DEPEND ON TEMPERATURE & ENERGY.

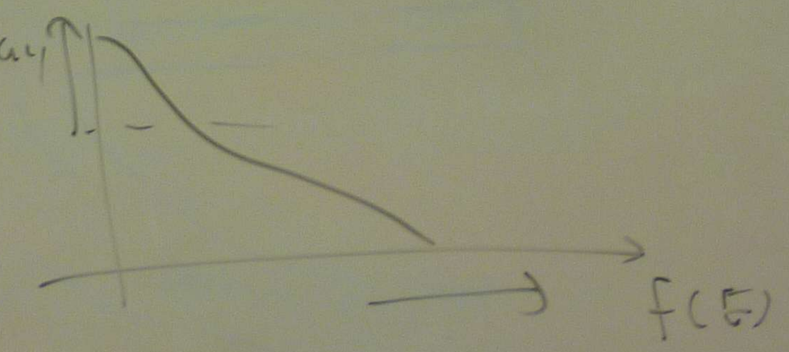
ENERGY DIFFERENCE $m = \dfrac{2^{9/2}\, m^{3/2}\, \pi}{3h^2} (E - E_V)^{3/2}$

RATE OF CHANGE OF ENERGY DIFFERENCE $S(E) = \dfrac{dm}{dE} = \dfrac{2^{7/2}\, m^{3/2}\, (E - E_V)^{1/2}}{h^2}$

ENERGY DENSITY $S(E) \times dE = dm$ = TOTAL NUMBERS of AVAILABLE STATES IN ENERGY RANGE dE

$F(E)$ = PROBABILITY of THE STATES. = FERMI FACTOR

$N(E)$ = SMALL ENERGY RANGE



FERMI LEVEL

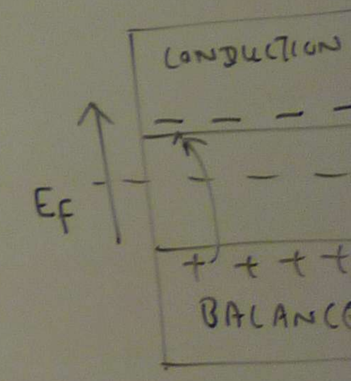
ENERGY WHE
STATES ARE

CONDUCTION B

$1 - F(E) =$

VARIATION of

INTRINSIC



$)^{3/2}$

$(E-E_V)^{1/2}$

RS of AUALLABLE
ENERGY RANGE

S. = FERMI FACTOR

→ f(E)

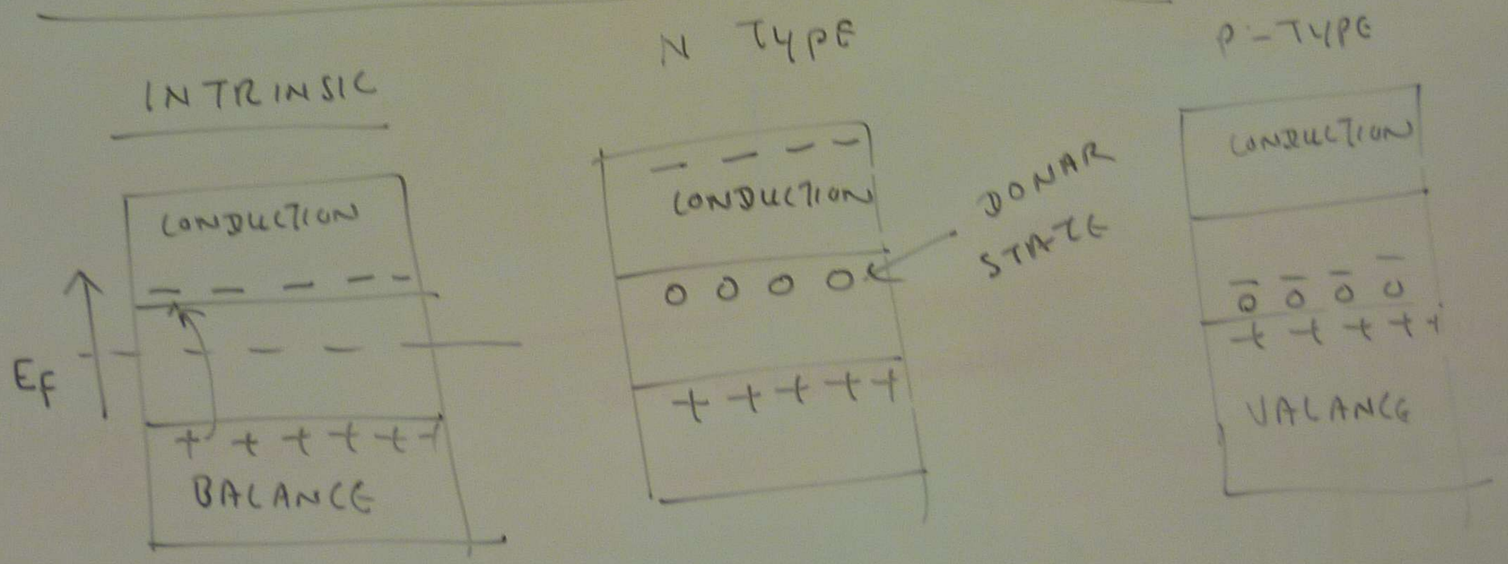
FERMI LEVEL

ENERGY WHERE THE PROBABILITY of ELECTRON STATES ARE OCCUPIED

CONDUCTION BAND

1— F(E) = PROBABILITY OF POSITIVE HOLES.

VARIATION of FERMI LEVEL WITH TEMPERATURE



TUTORIAL

Q 38

EXPLAIN THE ATOMIC STRUCTURE OF SEMI CONDUCTOR

Q39.

SKETCH ATOMIC STRUCTURE AND ENERGY MODEL OF P AND N TYPE SEMI CONDUCTORS

Q40

WRITE ENERGY DENSITY EQUATION FOR SEMI CONDUCTOR

Q41

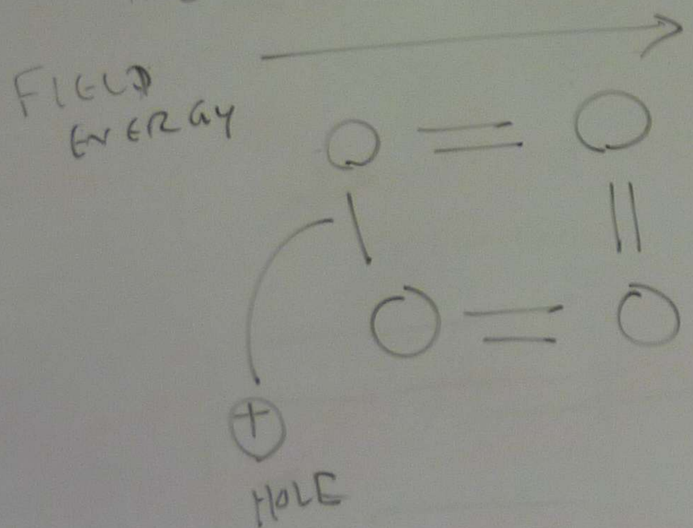
ACCORDING TO THE KINETIC THEORY OF GASES, THE AVERAGE KINETIC ENERGY OF GAS MOLECULE AT AN ABSOLUTE TEMPERATURE T IS EQUAL TO $\frac{3kT}{2}$ WHERE k IS BOLTZAMAN'S CONSTANT, WHAT IS AVERAGE ENERGY

$$T = 300k$$

038

AT ROOM TEMPERATURE, VALANCE BAND IS COMPLETELY FULL.
CONDUCTION BAND IS EMPTY.

AT OTHER TEMPERATURE FEW ELECTRONS GAIN ENERGY
TO TRANSVERSE THE FORBIDDEN GAP TO CONDUCTION BAND
AND LEAVE .POSITIVE HOLES IN VALANCE BAND



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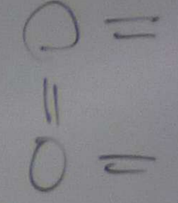


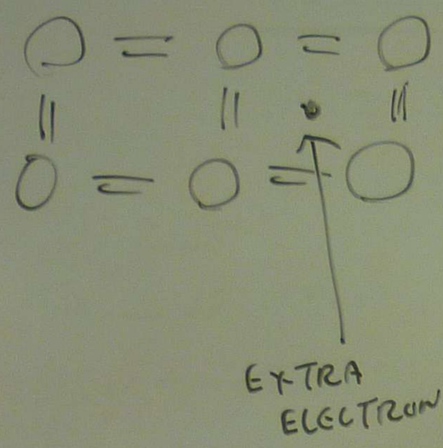
040

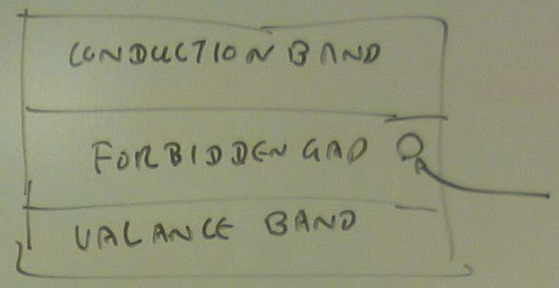
M

...PLETELY FULL.

...N ENERGY
...LCTION BAND
...D

039





$$E_n^1 = \frac{-me^4}{8m^2h^2\varepsilon_0^2\varepsilon_r^2}$$

040

$$n = \frac{2^{9/2}\, m^{3/2}\, \pi\, (E - E_V)^{3/2}}{3h^3}$$

n = ENERGY DENSITY E = ENERGY AT ANY STATE

m = MASS OF ATOM

h = PLANK CONSTANT

E_V = VALANCE STATE ENERGY

041

...ELECTRON

KINETIC ENER...

ENERGY =

...ELECTRON

KINE...

NERGY
STATE of
XTRA ELECTRON

NUMBER of ELECTRONS
DEPEND ON TEMPERAT

ENERGY DIFFEREN

RATE of CHANGE
ENERGY DIFF

ENERGY DENSITY

F

Q 41

$$\text{ELECTRON ENERGY} = \frac{\text{ENERGY}}{1.6 \times 10^{-19}} \qquad 1eV = 1.6 \times 10^{-19}\ J$$

$$\text{KINETIC ENERGY} = \frac{1}{2} m U^2 \quad | \quad U = \text{VELOCITY}$$

$$\text{ENERGY} = \frac{3}{2} kT = \frac{3}{2} \times 1.38 \times 10^{-23} \times 300 = 6.21 \times 10^{-21}\ J$$

$$\text{ELECTRON ENERGY} = \frac{6.21 \times 10^{-21}}{1.6 \times 10^{-19}} = 0.0388\ eV$$

$$\text{KINETIC ENERGY} = \frac{1}{2} mv^2 = 6.21 \times 10^{-21}$$

$$\frac{1}{2} \times 9.107 \times 10^{-31} \times v^2 = 6.21 \times 10^{-21}$$

$$v = 2725\ ms^{-1}$$

Pb

CALCULATE THE KINETIC ENERGY, POTENTIAL ENERGY AND TOTAL ENERGY of AN ELECTRON IN THE GROUND STATE of A HYDROGEN ATOM.

GROUND STATE LEVEL ENERGY

TOTAL ENERGY = KINETIC ENERGY + POTENTIAL ENERGY

$$\frac{mv^2}{r} = \frac{e^2}{4\pi\epsilon_0 r_1}$$

$$KE = \frac{1}{2}mv^2$$

$$PE = -\frac{e^2}{4\pi\epsilon_0 r_1}$$

$$\frac{1}{2}mv^2 = \frac{1}{2} \times \frac{e^2}{4\pi\epsilon_0 r_1}$$

$$= \frac{1}{2} \times \frac{(1.6\times10^{-19})^2}{4\times3.14\times8.854\times10^{-12}\times0.529\times10}$$

$$= 2.175\times10^{-18}\ J$$

$$1\ eV = 1.6\times10^{-19}\ J$$

$$\frac{2.175\times10^{-18}}{1.6\times10^{-19}} = 13.6\ eV$$

Pb

Pb

CALCULATE THE ENERGY AND RADII of FIRST FOUR ORBITS FOR AN ELECTRON IN A HYDROGEN ATOM.

ENERGY

$$KE = \frac{1}{2} m v^2$$

$$PE = -\frac{e^2}{4\pi \varepsilon_0 r^2}$$

TOTAL ENERGY $= KE + PE = \frac{1}{2} m v^2 + \left(-\frac{e^2}{4\pi \varepsilon_0 r^2}\right)$ ✓

$$m v r = \frac{n h}{2\pi}$$

$$v = \frac{n h}{m r n \pi}$$

$$\frac{1}{2} m v^2 = \frac{-e^2}{4\pi \varepsilon_0 r^2}$$

$$\frac{1}{2} m \left[\frac{n h}{m r n \pi}\right]^2 = \frac{-e^2}{4\pi \varepsilon_0 r^2}$$

$$\frac{h}{2r\pi} = \frac{-e^2}{4\pi \varepsilon_0 r^2}$$

$$\frac{h}{2\pi} = \frac{-e^2}{4\pi \varepsilon_0 r}$$

$$4\pi \varepsilon_0 r h = -2\pi e^2$$

$$r = \frac{-2\pi e^2}{4\pi \varepsilon_0 h}$$ ✓

Pb

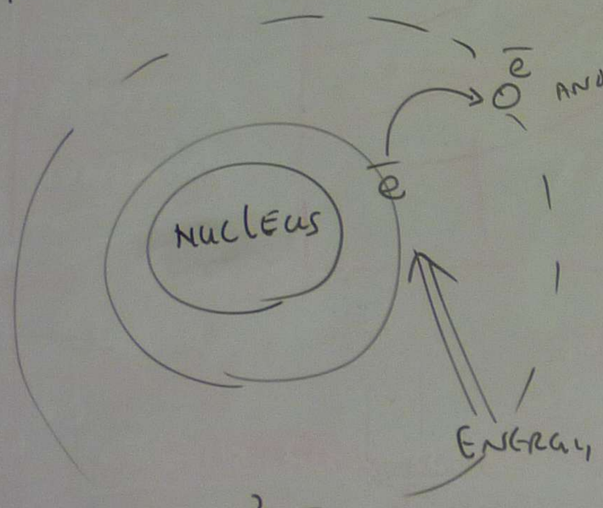
AN ELECTRON IN A HYDROGEN ATOM MAKES A TRANSISTOR FROM A QUANTUM STATE of PRINCIPAL QUANTUM NUMBER $n=2$ TO THE GROUND STATE. WHAT IS THE ENERGY AND WHAT IS THE FREQUENCY FOR EMITTED LIGHT QUANTUM.

ADV THEORY 1

PAGE 1 ⟶ 10

ADV THEORY 2

P31 ⟶ 65.



CHANGE OF STATE IS ASSOCIATED WITH ENERGY EMISSION

$$hf = |W_2 - W_1|$$

PLANK CONSTANT — FREQUENCY — ENERGY CHANGE

$$f = \frac{|W_2 - W_1|}{h}$$

$$f = \frac{\left|\frac{-13.6}{2^2} - \frac{(-13.6)}{1^2}\right|}{6.254 \times 10^{-24}}$$

$$=$$

$$\frac{mv^2}{r_1} = \frac{e^2}{4\pi\epsilon_0 r_1^2}$$

$$W = KE + PE$$

$$V = \frac{-e^2}{8\pi\epsilon_0 r_1}$$

$$mvr = \frac{nh}{2\pi} \rightarrow V = \frac{nh}{2\pi mr}$$

$$\frac{1}{2}mv^2 = \frac{e^2}{8\pi\epsilon_0 r_1}$$

$$\frac{1}{2}m\left[\frac{nh}{2\pi mr}\right]^2 = \frac{e^2}{8\pi\epsilon_0 r_1}$$

$$r = 529 \times 10^{-19}\ m^2$$

$$W_h = \frac{-e^2}{8\pi\epsilon_0 \times 0.529 \times 10^{-19}}$$

$$= -\frac{13.6}{n^2}\ eV$$

$$W_1 = -\frac{13.6}{1^2}$$

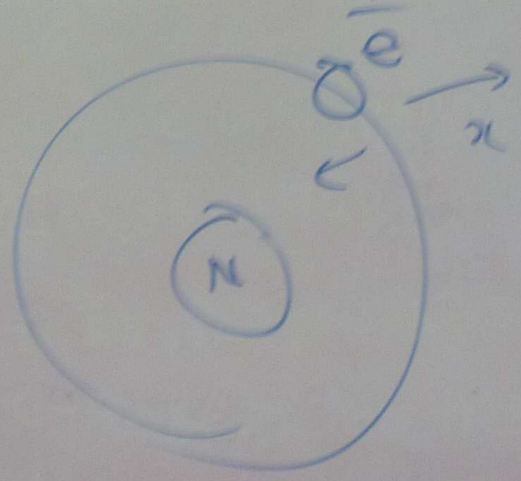
$$W_2 = -\frac{13.6}{2^2}$$

THE ENERGY of TWO PARTICLES IN THE FIELD OF EACH OTHER

$$W(r) = -\frac{\alpha}{r} + \frac{\beta}{r^2}$$

ATTRACTION FORCE — REPULSION FORE

POTENTIAL ENERGY



ENERGY TR

FORCE = $\frac{e}{4\pi}$

ENERGY = FORCE

Q 45

Suppose

ENERGY of

ELECTRON ATTR

A AND B

WHAT IS THE

AN ELECTRON

O PARTICLES IN THE

ER

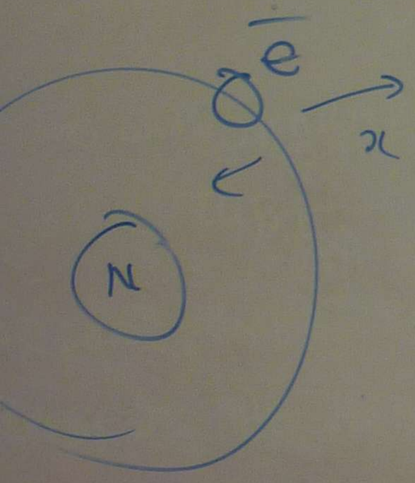
$$+ \frac{\beta}{r^2}$$

↑

ACTION REPULSION

FORCE

ENTIAL ENERGY



ENERGY TRANSFER FROM ATOM TO ELECTRON

$$\text{FORCE} = \frac{e^2}{4\pi E_0 r^2}$$

ENERGY = FORCE × DISTANCES MOVE

Q45 SUPPOSE AN ATOM 'A' HAS AN IONIZATION ENERGY OF 9 eV AND ATOM 'B' HAS AN ELECTRON ATTAINING of 4 eV. SUPPOSE ATOM A AND B ARE 9 ARMSTRONG APART. WHAT IS THE ENERGY REQUIRED TO TRANSFER AN ELECTRON FROM A TO B?

FORCE BETWEEN A

ENERGY REQUIRED

THE ATOM

DI ELECT

∮

ATOM TO ELECTRON

MOVE

HAS AN IONIZATION

TOM 'B' HAS AN

EV. SUPPOSE ATOM

TRONG APART.

UIRED TO TRANSFER

B?

FORCE BETWEEN A. AND B $= \frac{c^2}{4\pi E_0 r^2}$

$= \frac{(1.6 \times 10^{-19})^2}{4 \times 3.1416 \times 8.854 \times 10^{-12} \times (5 \times 10^{-10})^2}$

$F = 9.2 \times 10^{-10}$ N

ENERGY REQUIRED TO MOVE THE ATOM $W = F \times x$

$= 9.2 \times 10^{-10} \times 5 \times 10^{-10}$

$= 4.502 \times 10^{-19}$ J

D = ELECTRIC
DENSIT

dS = CURVATU

$\sum Q$ = Sum o
CHARG

CHARE

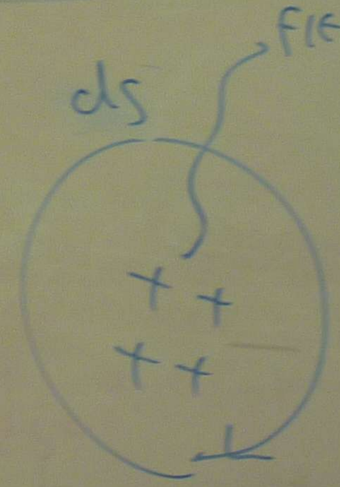
POT

NEAR THE C

HIGHER PO

D1 ELECTRIC PROPERTIES OF INSULATORS IN STATIC FIELD

$\oint D \, ds = \sum Q$



$\times 10^{-12} \times (5 \times 10^{-10})^2$

-10
0

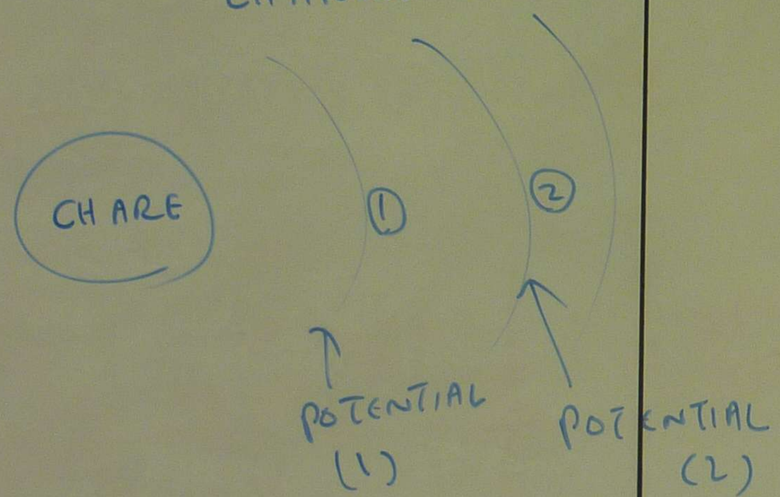
ATORS IN

FIELD DENSITY
(D)

D = ELECTRIC FIELD DENSITY

ds = CURVATURE

$\sum Q$ = Sum of ELECTRIC CHARGES



NEAR THE CHARGE,

HIGHER POTENTIAL

ELECTRICITY INTENSITY DEPENDS ON THE DISTANCE FROM THE ELECTRIC CHARGE

$$V_1 - V_2 = -\int E \, dr$$

$$U(r) = \frac{Q}{4\pi E_0 r}$$

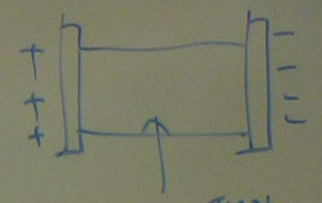
Q = ELECTRIC CHARGE (C)

$E_0 = 8.854 \times 10^{-12}$

r = DISTANCE

U(r) = POTENTIAL

CAPACITOR



CAPACITOR CAN ST
CHARGE & ENE

$$V = \frac{E}{d}$$

$$C = \frac{Q}{V}$$

$$C = \frac{\varepsilon_0 \varepsilon_r}{d}$$

A - AREA

d - DISTA

ITY INTENSITY DEPENDS ON

STANCE FROM THE ELECTRIC CHARGE

$$V_2 = -\int E \, dr$$

$$) = \frac{Q}{4\pi E_0 r}$$

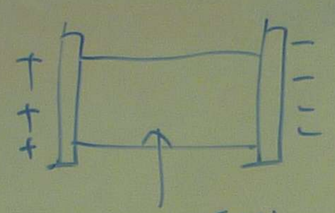
ELECTRIC CHARGE (C)

8.854×10^{-12}

DISTANCE

r) = POTENTIAL

CAPACITOR



INSULATION
(DI ELECTRIC)

CAPACITOR CAN STORE THE ELECTRIC CHARGE & ENERGY

$$V = \frac{E}{d}$$

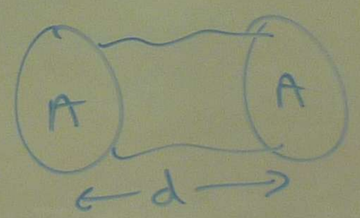
$$C = \frac{Q}{V}$$

C = CAPACITANCE

Q = CHARGE

V = VOLTAGE

$$C = \frac{\varepsilon_0 \varepsilon_r A}{d}$$



A – AREA OF PLATE

d – DISTANCE

ε_0 = PERMITIVITY

ε_r = RELATIVE PERMITIVITY

CURRENT = RATE OF
ELECTRIC

$$I = J \times A$$

I = ELECTRIC CURRE

J = CHARGE DENSI

A = AREA (m^2)

ELECTRICAL CON
CONDUCTOR

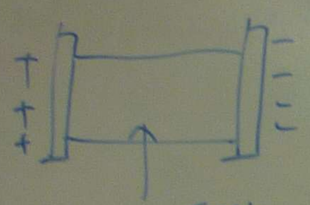
$$mvr =$$

m = MASS OF AT

V = VELOCITY

r = DISTANCE

CAPACITOR



INSULATION
(DIELECTRIC)

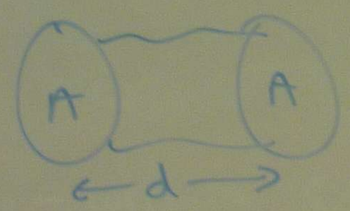
CAPACITOR CAN STORE THE ELECTRIC CHARGE & ENERGY

$$V = \frac{E}{d}$$

$$C = \frac{Q}{V}$$

C = CAPACITANCE
Q = CHARGE
V = VOLTAGE

$$C = \frac{\varepsilon_0 \varepsilon_r A}{d}$$



A - AREA OF PLATE
d - DISTANCE

ε_0 = PERMITIVITY

ε_r = RELATIVE PERMITIVITY

CURRENT = RATE OF CHANGE OF ELECTRIC CHARGE

$$I = J \times A$$

I = ELECTRIC CURRENT (AMP)

J = CHARGE DENSITY / CURRENT DENSITY
Amp/m^2

A = AREA (m^2)

ELECTRICAL CONDUCTION IN SEMI CONDUCTORS

$$mvr = \frac{nh}{\pi}$$

m = MASS OF ATOM
v = VELOCITY
r = DISTANCE

n = ORBIT NUMBER
h = PLANK CONSTANT

V

V = VOL

E = E

046 A

HAS

WHA

6 V

$$V = \mu E$$

V = VOLTAGE , μ = CONSTANT

E = ELECTRIC FIELD INTENSITY

046 A GERMASIUM CRYSTAL SPECIMEN 1 mm HAS A TOTAL OF 2.5×10^{7} ELECTRONS IN IT'S CONDUCTION BOND. WHAT ELECTRON CURRENT FLOWS WHEN THERE IS A FIELD OF $6\ V\ cm^{-1}$ PARALLEL TO ONE FACE OF CUBE.

$\mu = 3900$ FOR GERMASIUM

$V = \mu E = 3900 \times 6 = 23400\ V$

$$\boxed{J_n = n\ e\ V}$$

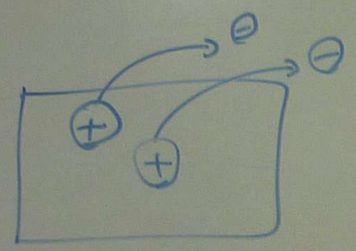
J_n = ELECTRON CURRENT DENSITY Amp/cm

e = ELECTRON CHARGE

V = VOLT

$$J_n = 2.5 \times 10^{7} \times 1.601 \times 10^{-19} \times 23400 = 9.36 \times 10^{-8}\ \text{Amp/cm}$$

ELECTRONS & HOLES IN SEMI CONDUCTOR



$$\frac{1}{2} m U^2 = E - E_F$$

FERMI LEVEL

$$f(E) = \frac{1}{1 + e^{\frac{E-E_F}{273}}}$$

$$f(E) = \frac{1}{1+}$$

AT 0 K,

Q47 DETERMINE THE AVERAGE ENERGY OF AN ELECTRON IN CONDUCTION BAND OF METAL AT 0 K AS A FUNCTION OF FERMI LEVEL.

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$$f[E] = \frac{1}{1 + e^{\frac{E - Ef}{273}}}$$

AT $0^{\circ}K$, $E = \frac{2}{3} Ef$

-AGE
IRON
F METAL
N OF

ph / A METAL HAS IT'S FERMI LEVEL 8.95 eV ABOVE THE BOTTOM of CONDUCTION BAND. WRITE THE EQUATION FOR MOMENTUM OF ELECTRON.

$$\frac{1}{2} m v^2 = E - E_f$$

$$\text{ENERGY STATE}/\text{VOL} = \frac{2 m^{3/2} \pi^{9/2} (E - E_f)^{3/2}}{3 h^3}$$

$$= 2 \frac{\times (9.1 \times 10^{-21})^{3/2} \times 3.14^{9/2} \times 8.95^{3/2}}{3 \left[6.624 \times 10^{-34} \right]^3}$$

$=$

D = ELECTRIC FIELD DENSITY

ds = CURVATURE

ΣQ = Sum of ELECTR
CHARGES

CHARE

① ②

POTENTIAL (1)

NEAR THE CHARGE,
HIGHER POTENTIAL

$$f(E) = \frac{1}{1 + e^{\frac{E - Ef}{273}}}$$

$e^{\frac{E-Ef}{273}}$

AT $0^{\circ}K$, $E = \frac{2}{3} Ef$

NE THE AVERAGE
OF AN ELECTRON
CTION BAND OF METAL
AS A FUNCTION OF
LEVEL.

ph/ A METAL HAS IT'S FERMI LEVEL 8.95 eV ABOVE THE BOTTOM of CONDUCTION BAND. WRITE THE EQUATION FOR momentum of ELECTRON.

$$\frac{1}{2} m v^2 = E - E_f$$

$$\text{ENERGY STATE}\Big|_{VOL} = \frac{2 m^{3/2} \pi^{9/2} (E - E_f)^{3/2}}{3 h^3}$$

$$= 2 \frac{\pi^{9/2} \times (9.1 \times 10^{-21})^{3/2} \times 3.14 \times 8.95^{3/2}}{3 \left[6.624 \times 10^{-34}\right]^3}$$

$=$

D = ELECT
DE
ds = CUR
$\sum \Theta$ = SU
CH

CHARE

NEAR T
HIGHE

$$f(E) = \frac{1}{1 + e^{\frac{E - E_f}{273}}}$$

$e^{\frac{E-E_f}{273}}$

AT $0^\circ K$, $E = \frac{2}{3} E_f$

DETERMINE THE AVERAGE ENERGY OF AN ELECTRON IN CONDUCTION BAND OF METAL AT $0^\circ K$ AS A FUNCTION OF FERMI LEVEL.

ph/ A METAL HAS IT'S FERMI LEVEL 8.95 eV ABOVE THE BOTTOM OF CONDUCTION BAND. WRITE THE EQUATION FOR MOMENTUM OF ELECTRON.

$$\frac{1}{2} m v^2 = E - E_f$$

$$\text{ENERGY STATE/VOL} = \frac{2 m^{3/2} \pi^{3/2} (E - E_F)^{3/2}}{3 h^3}$$

$$= 2 \frac{(9.1 \times 10^{-21})^{3/2} \times 3.14 \times 8.95^{3/2}}{3 \left[6.624 \times 10^{-34}\right]^3}$$

=

USED LUMINAIRES

USAGE OF ENERGY.

HOURS IN PUBLIC

ST REDUCED BY

LIC SWITCHING

NG SWITCH

T

LE TIME

Q46

A GERMASIUM CRYSTAL SPECIMEN 1cm³ HAS A TOTAL OF $2.5 \times 10^{?}$ ELECTRONS IN IT'S CONDUCTION BOND, WHAT ELECTRON CURRENT FLOWS WHEN THERE IS A FIELD OF $6\ V\ cm^{-1}$ PARALLEL TO ONE FACE OF CUBE?

$V = \mu E$

$\mu = 3400$

$E = 6\ V/cm$

$V = 3400 \times 6 = 23400$

J_{en} = ELECTRON CURRENT = $n_e \times V$

$= 2.5 \times 10^{7} \times 1.601 \times 10^{-19} \times 23400$

$= 9.36 \times 10^{-8}$ Amp/cm

n_e = NO. OF ELECTRONS IN CONDUCTION BAND

e = ELECTRON CHARGE 1.601×10^{-19}

Q47

DETERMINE

IN CONDUCT

OF FER

F(E)

Q48

A

A HALL

AND REC

HALL E

DENSITY

R

RH

1 HAS A TOTAL OF

WHAT ELECTRON

$6\ V\ cm^{-1}$ PARALLEL.

= 3900

= 6 V/cm

n_e = NO. OF ELECTRONS IN CONDUCTION BAND

e = ELECTRON CHARGE 1.601×10^{-19}

Q47

DETERMINE THE AVERAGE ENERGY OF AN ELECTRON IN CONDUCTION BAND OF METAL AT 0 K AS FUNCTION OF FERMI LEVEL.

$$f(E) = \frac{1}{1 + e^{\frac{E - E_F}{273}}}$$

Q48 A SPECIMEN OF A SEMI CONDUCTOR HAS A HALL EFFECT COEFFICIENT of $3.6 \times 10^{-4}\ m^3\ C^{-1}$ AND RESISTIVITY of $8.93 \times 10^{-7}\ \Omega\text{-cm}$. IN A HALL EFFECT EXPERIMENT, MAGNETIC FLUX DENSITY IS $0.5\ wb/m^2$, FIND HALL ANGLE.

R_H = HALL EFFECT COEFFICIENT $3.6 \times 10^{-4}\ m^3$ COULOMB

$$R_H = \frac{E_y}{R_x J_x} = -\frac{1}{e n_e}$$

E_y = Y AXIS FIELD DENSITY

J_x = CURRENT DENSITY (X-AXIS)

B_x = X-AXIS FLUX DENSITY

HALL EFFECT

FLUX

FORCE

ELECTRIC CURRENT

MICROPHONE

FORCE - VOICE

MAGNETIC MATERIAL INSIDE

HALL AN

$B_x = 0.5$

$3.6 \times 10^{-4} = \frac{E}{0.5}$

J_x = CURRENT DENSIT

E = VOLT

ρ = RESISTIVIT

L = LENGTH

A = C.SA

BUT

$R = \frac{\rho L}{A}$

F AN ELECTRON

T AS FUNCTION

UCTOR HAS

$.6 \times 10^{-4}\ m^3\ C^{-1}$

m. IN A

ETIC FLUX

IALL ANGLE.

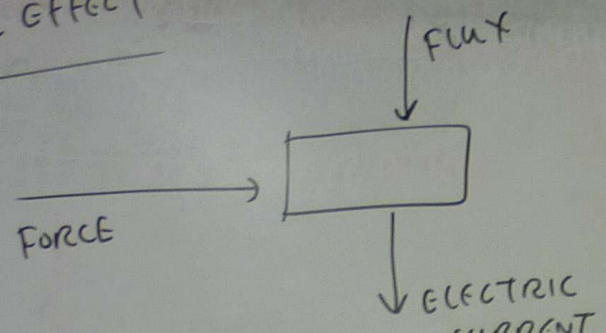
$3.6 \times 10^{-4}\ m^3$ COULOMB^{-1}

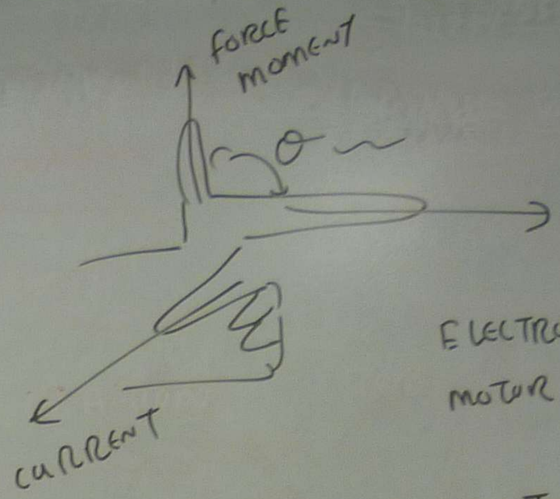
E_y = Y AXIS FIELD DENSITY

J_x = CURRENT DENSITY (X-AXIS)

B_x = X-AXIS FLUX DENSITY

HALL EFFECT





ELECTROMAGNETIC MOTOR

MICROPHONE

FORCE - VOICE

MAGNETIC MATERIAL INSIDE ⟹ MODULATED SIGNAL CURRENT ⟹ AMPLIFIER ⟹ DRIVER

HALL ANGLE - ANGLE BETWEEN FORCE & FLUX

$B_x = 0.5$

$$3.6 \times 10^{-4} = \frac{E_y}{0.5 \times J_x} \quad \text{—— (1)}$$

J_x = CURRENT DENSITY $= \frac{\text{CURRENT}}{\text{AREA}} = \frac{I}{A}$

E = VOLT
ρ = RESISTIVITY
L = LENGTH
A = C.S.A

$$= \frac{E/R}{A}$$

$$= \frac{E}{RA}$$

BUT $R = \frac{\rho L}{A}$

$$= \frac{E}{\frac{\rho L}{A} \times A}$$

E_x - X-AXIS ELECTRICAL VOLTAGE

$$J = \frac{E_x}{\rho L} \quad \text{—— (2)}$$

(2) → (1)

$$3.6 \times 10^{-4} = \frac{E_y}{0.5 \times \frac{E_x}{\rho L}}$$

$$3.6 \times 10^{-4} = \frac{E_y}{E_x} \times \frac{\rho L}{0.5} \qquad l = 1\text{cm}$$

$$\frac{E_y}{E_x} = \frac{0.5 \times 3.6 \times 10^{-4}}{\rho L}$$

$$\tan\theta = \frac{0.5 \times 3.6 \times 10^{-4}}{8.93 \times 10^{-3} \times 1} =$$

$\theta = 1.1$

SOLID, LIQUID, GASES

SOLID

- RIGID STRUCTURE
- RESISTANCE TO CHANGE OF SHAPE / VOLUME
- DOES NOT FLOW LIKE AS LIQUID
- DOES NOT FILL THE CONTAINER LIKE AS GAS.

LIQUID / GAS — LOOSE STRUCTURE

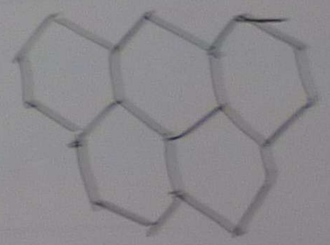
Q1 DEFINE SOLID

SOLID IS CHARACTERIZED BY STRUCTURAL RIGIDITY AND RESISTANCE TO CHANGE OF SHAPE (OR) VOLUME.

SOLID

SOLID MOLECULE STRUCTURE

Q2 EXPLAIN THE BOU
OF SOLIDS.



SCHE
OF A
AND
LAT
CH

QUID , GASES

RE
HANGE OF SHAPE / VOLUME

OW LIKE AS LIQUID

THE CONTAINER LIKE AS GAS.

— LOOSE STRUCTURE

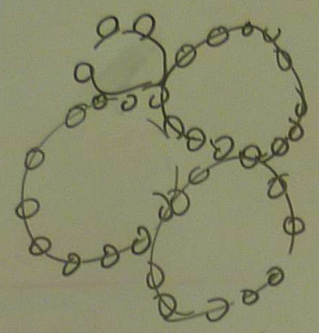
E SOLID

ARACTERIZED BY STRUCTURAL

ND RESISTANCE TO CHANGE

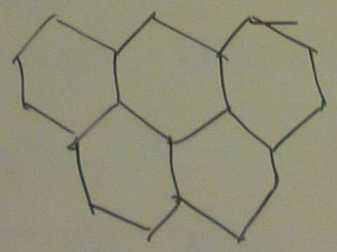
OR) VOLUME.

SOLID



SOLID MOLECULE STRUCTURE.

Q2 EXPLAIN THE BOUNDARY OF SOLIDS.



SCHEMATIC REPRESENTATION OF A RANDOM-NETWORK AND ORDERED CRYSTALLINE LATTICE OF IDENTICAL CHEMICAL COMPOSITION

SOLID → METALLIC
→ NON METALLIC

Q3 EXPLAIN THE CHARACTE
METAL

METALS TYPICALLY ARE DENSE AND GOOD CONDUCTO
ELECTRICITY AND HEAT.

BONDING IN SOLIDS

METAL — IONIC BOND

SILICON — COVALENT BO

ORGANIC COMPOUND - VAN
BON

CHARGE

POLA
ELE

TURE.

BOUNDARY

TCHEMATIC REPRESENTATION
F A RANDOM-NETWORK
AND ORDERED CRYSTALLINE
LATTICE OF IDENTICAL
CHEMICAL COMPOSITION

SOLID → METALLIC
SOLID → NON METALLIC

Q3 EXPLAIN THE CHARACTERISTICS OF METAL

METALS TYPICALLY ARE STRONG, DENSE AND GOOD CONDUCTORS OF BOTH ELECTRICITY AND HEAT.

BONDING IN SOLIDS

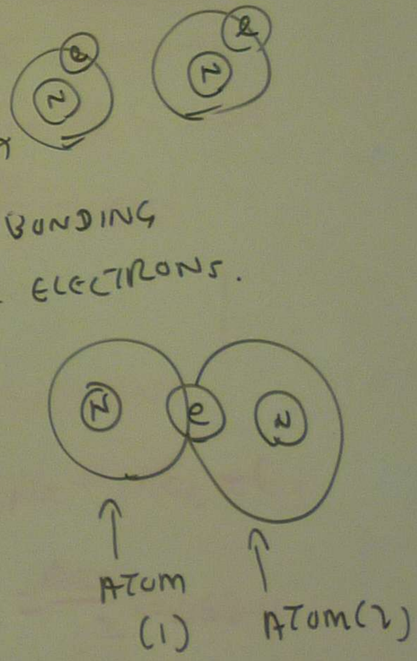
METAL — IONIC BOND —— ELECTRONS ARE SHARED IN METALLIC BONDING

SILICON — COVALENT BOND —— ATOMS SHARE ELECTRONS.

ORGANIC COMPOUND — VAN DER WAAL BOND

CHARGE

POLARIZATION of ELECTRIC CHARGE CLOUD



Q4 WHAT IS M

IN METALS, THE E
IN METALLIC BO
METALIC SOLIDS
BY A HIGH DENS
DE LOCALIZED ELE
METALLIC BONDING
ARE SPREAD OVE
IN METAL, ATOM
OUTER MOST ELE
THE FREE ELECTR
TOGETHER FIR
INTERACTIONS
& ELECTRON

Q4 WHAT IS METALLIC BONDING?

IN METALS, THE ELECTRONS ARE SHARED IN METALLIC BONDING.

METALIC SOLIDS ARE HELD TOGETHER BY A HIGH DENSITY of SHARED, DELOCALIZED ELECTRONS, KNOWN AS METALLIC BONDING. THE FREE ELECTRONS ARE SPREAD OVER THE ENTIRE SOLID IN METAL, ATOMS READILY LOSE THEIR OUTERMOST ELECTRONS.

THE FREE ELECTRONS ARE HELD TOGETHER FIRMLY BY ELECTROSTATIC INTERACTION BETWEEN THE IONS & ELECTRON CLOUDS.

LIQUID

Q6 DEFINE LIQUID

LIQUID IS THE ONLY STATE WITH A DEFINITE VOLUME BUT NO FIXED SHAPE.

A LIQUID IS MADE UP of TINY VIBRATING PARTICLES OF MATTER, SUCH AS ATOMS AND MOLECULES HELD TOGETHER BY INTRAMOLECULAR BONDS.

Q7 HOW DOES LIQUID PARTICLES BOUND?

LIQUID MOLECULES ARE HELD TOGETHER BY INTRA MOLECULAR BONDS.

LIQUID VOLUME DEPENDS ON PRESSURE AND TEMPERATURE

$$\frac{PV}{T} = \text{CONSTANT}$$

P = PRESSURE
V = VOLUME
T = TEMPERATURE

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PRESSURE AND BUOYANCY

$$P = \rho g h$$

P = PRESSURE
ρ = DENSITY
g = GRAVITY
h = DEPTH OF LIQUID

Q8 DESCRIBE THE FOLLOWINGS

(a) VOLUME (b) PRESSURE & BUOYANCY.

(a) VOLUME OF A QUANTITY OF LIQUID IS FIXED BY PRESSURE AND TEMPERATURE. QUANTITIES OF LIQUIDS ARE COMMONLY MEASURED IN UNITS OF VOLUME.

(b) IN A
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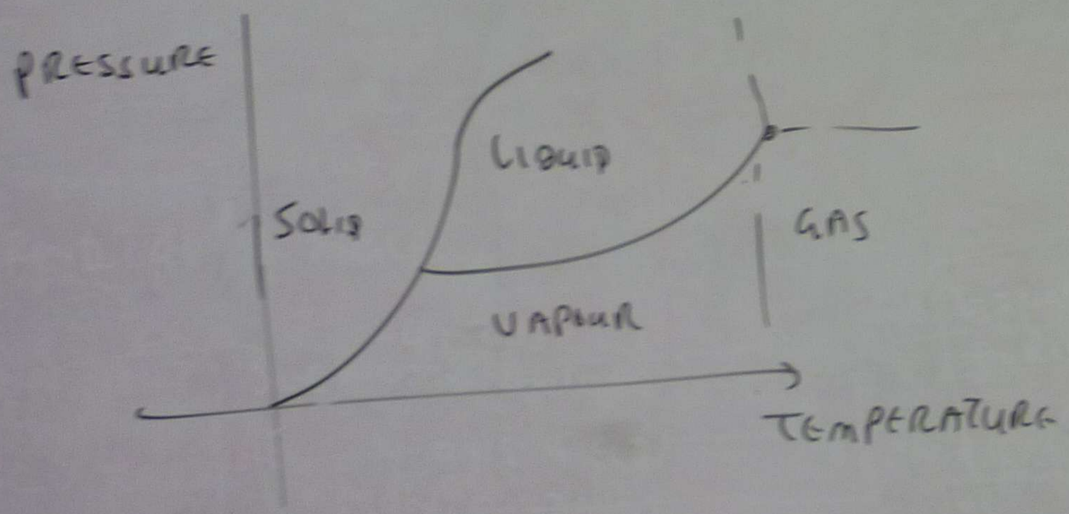
(b) IN A GRAVITATIONAL FIELD, LIQUIDS EXERTS PRESSURE ON THE SIDES OF A CONTAINERS AS WELL AS ON ANYTHING WITHIN THE LIQUID ITSELF. THIS PRESSURE IS TRANSMITTED IN ALL DIRECTION AND INCREASES WITH DEPTH.

OBJECTS IMMERSED IN LIQUIDS ARE SUBJECT TO PHENOMENON OF BUOYANCY



Q10 WHAT IS GAS?

A PURE GAS MAY BE MADE UP OF INDIVIDUAL ATOMS, ELEMENTAL MOLECULES MADE FROM ONE TYPE OF ATOM OR COMPOUND MOLECULES MADE FROM VARIETY OF ATOMS

O_2 , WATER VAPOUR H_2O

Q11 WHAT ARE THE PROPERTIES OF GAS.

GAS PARTICLES ARE WIDELY SEPARATED FROM ONE ANOTHER AND HAVE WEAKER INTERMOLECULAR BONDS THAN LIQUID AND SOLID.

GAS CHARACTERISTICS ARE PRESSURE, TEMPERATURE VOLUME AND NUMBER OF PARTICLES.

SPECIFIC VOLUME: INTENSIVE PROPERTY

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}.$$

PERFECT GAS

$$PV = m R T$$

P = PRESSURE

V = VOLUME

m = NO_OF MOLECULES

R = CONSTANT (8.314 J/mol K)(SPECIFIC GAS CONSTANT)

T = TEMPERATURE

IDEAL GAS

IT IS SIMPLIFIED AS REAL GAS WITH COMPRESSIBILITY IS SET TO 1.

Q13

THE IDEAL

SET TO

Q14

- VARIABLE

Q13 DESCRIBE IDEAL AND PERFECT GAS MODEL.

THE EQUATION $PV = mRT$ IS STATED FOR AN IDEAL (OR) PERFECT GAS

THE IDEAL GAS LAW APPLIES WITHOUT RESTRICTIONS ON THE SPECIFIC HEAT. THE COMPRESSIBILITY FACTOR Z IS SET TO 1.

Q14 DESCRIBE THE REAL GAS EFFECT.

- COMPRESSIBILITY EFFECTS (Z ALLOWED TO VARY FROM 1.0
- VARIABLE HEAT CAPACITY (SPECIFIC HEAT VARY WITH TEMPERATURE)
- VAN DER WAAL FORCE (RELATED TO COMPRESSIBILITY, CAN SUBSTITUTE OTHER EQUATIONS OF STATE.
- NON EQUILIBRIUM THERMODYNAMICS EFFECTS
- ISSUES WITH MOLECULAR DISSOCIATION AND ELEMENTARY REACTIONS WITH VARIABLE COMPOSITION.

COMPRESSIBILITY

Boyle's Law

CHARLE'S LAW

AVOGRADO'S

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$\frac{V}{n}$ =

Q16 WRIT

G

P_T

Q13 DESCRIBE IDEAL AND PERFECT GAS MODEL.

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BOYLE'S LAW $P.V = \text{CONSTANT}$

CHARLE'S LAW $\frac{V}{T} = \text{CONSTANT}$

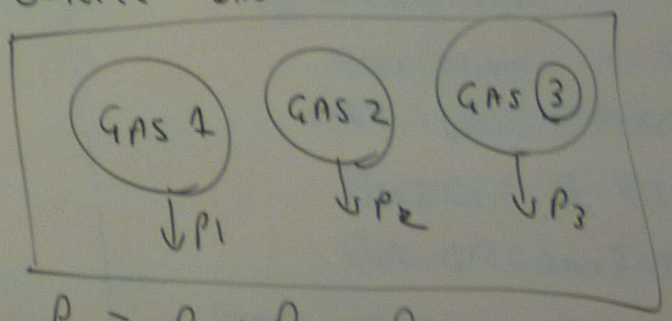
AVOGRADO'S LAW

Q15 WRITE AVA GRADO'S LAW.

"EQUAL VOLUME OF PURE GASES CONTAIN THE SAME NUMBER OF PARTICLES".

$$\frac{V}{n} = \frac{RT}{P}$$ CONSTANT LAW.

Q16 WRITE DALTON'S LAW.



$$P_T = P_1 + P_2 + P_3$$

= CONSTANT

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RADO'S LAW.

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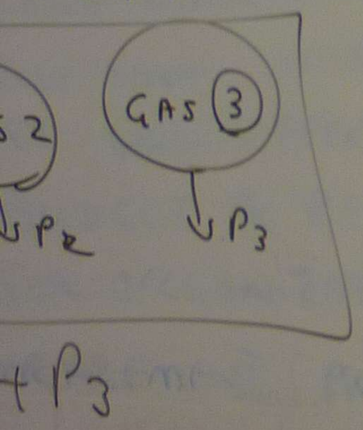

"THE PRESSURE OF A MIXTURE OF GASES IS EQUAL TO THE SUM OF THE PRESSURES OF ALL OF THE CONSTITUENT GASES ALONE"

$$\text{PRESSURE}_{\text{TOTAL}} = \text{PRESSURE}_1 + \text{PRESSURE}_2 + \text{----} + \text{PRESSURE}_n$$

Q17 WHAT IS REYNOLD'S NUMBER?

THE REYNOLD'S NUMBER IS THE RATIO OF INERTIAL FORCE ($v_s \rho$) TO VISCOUS FORCES (μ/L)

IT CAN BE USED TO CHARACTERIZE THE FLOW.

VISCOSITY

A PHYSICAL PROPERTY, IS MEASURED OF HOW WELL ADJACENT MOLECULES STICK TO ONE ANOTHER.

Q18 EXPLAIN THERMODYNAMIC EQUILIBRIUM

"WHEN ENERGY TRANSFER CEASES FROM A SYSTEM, THIS CONDITION IS REFERRED TO AS THERMODYNAMIC EQUILIBRIUM.

IT ALSO IMPLIES

FORCES ARE BALANCE

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"THE PRESSURE of A MIXTURE of GASES IS EQUAL TO THE SUM of THE PRESSURES of ALL of THE CONSTITUENT GASES ALONE"

$$\text{PRESSURE}_{\text{TOTAL}} = \text{PRESSURE}_1 + \text{PRESSURE}_2 + \text{----} + \text{PRESSURE}_n$$

Q12 WHAT IS REYNOLD'S NUMBER?

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"WHEN ENERGY TRANSFER CEASES FROM A SYSTEM, THIS CONDITION IS REFERRED TO AS THERMODYNAMIC EQUILIBRIUM.

IT ALSO IMPLIES THAT EXTERNAL FORCES ARE BALANCED AND ALL CHEMICAL REACTIONS WITHIN THE SYSTEM ARE BALANCED.

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layer *can* separate from the surface, essentially creating a new surface and completely changing the flow path. The classical example of this is a stalling airfoil. The delta wing image clearly shows the boundary layer thickening as the gas flows from right to left along the leading edge.

Maximum entropy principle

Main article: Principle of maximum entropy

As the total number of degrees of freedom approaches infinity, the system will be found in the macrostate that corresponds to the highest multiplicity. In order to illustrate this principle, observe the skin temperature of a frozen metal bar. Using a thermal image of the skin temperature, note the temperature distribution on the surface. This initial observation of temperature represents a "microstate." At some future time, a second observation of the skin temperature produces a second microstate. By continuing this observation process, it is possible to produce a series of microstates that illustrate the thermal history of the bar's surface. Characterization of this historical series of microstates is possible by choosing the macrostate that successfully classifies them all into a single grouping.

Thermodynamic equilibrium

Main article: Thermodynamic equilibrium

When energy transfer ceases from a system, this condition is referred to as thermodynamic equilibrium. Usually this condition implies the system and surroundings are at the same temperature so that heat no longer transfers between them. It also implies that external forces are balanced (volume does not change), and all chemical reactions within the system are complete. The timeline varies for these events depending on the system in question. A container of ice allowed to melt at room temperature takes hours, while in semiconductors the heat transfer that occurs in the device transition from an on to off state could be on the order of a few nanoseconds.

T2 Dielectric strength.doc (Protected View) - Microsoft Word
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0.5GV/m.[1] However very thin layers (below, say, 100 nm) become partially conductive because of electron tunneling. Multiple layers of thin dielectric films are used where maximum practical dielectric strength is required, such as high voltage capacitors and pulse transformers. Since the dielectric strength of gases varies depending on the shape and configuration of the electrodes, it is usually measured as a fraction of the dielectric strength of Nitrogen gas.

Dielectric strength (in MV/m, or 10^6 Volt/meter) of various common materials:

Substance	Dielectric Strength (MV/m)
Helium (relative to nitrogen)[2]	0.15
Air [3]	3.0
Alumina[2]	13.4
Window glass[2]	9.8 - 13.8
Silicone oil, Mineral oil[2][4]	10 - 15
Benzene[2]	163
Polystyrene[2]	19.7
Polyethylene[5]	18.9 - 21.7
Neoprene rubber[2]	15.7 - 26.7
Distilled Water[2]	65 - 70
High Vacuum (field emission limited)[6]	20 - 40 (depends on electrode shape)
Fused silica[7]	25–40 at 20 °C
Waxed paper[8]	40 - 60
PTFE (Teflon, Extruded)[2]	19.7
PTFE (Teflon, Insulating Film)[2][9]	60 - 173
Mica[2]	118

[edit] Units

In SI, the unit of dielectric strength is volts per meter (V/m). It is also common to see related

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Polystyrene[2]	19.7
Polyethylene[5]	18.9 - 21.7
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Distilled Water[2]	65 - 70
High Vacuum (field emission limited)[6]	20 - 40 (depends on electrode shape)
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PTFE (Teflon, Insulating Film)[2][9]	60 - 173
Mica[2]	118

[edit] Units

In SI, the unit of dielectric strength is volts per meter (V/m). It is also common to see related units such as volts per centimeter (V/cm), megavolts per meter (MV/m), and so on.

In United States customary units, dielectric strength is often specified in volts per mil (a mil is 1/1000 inch).[10] The conversion is:

$$1\ \mathrm{V/m} = 2.54 \times 10^{-5}\ \mathrm{V/mil}$$
$$1\ \mathrm{V/mil} = 3.94 \times 10^{4}\ \mathrm{V/m}$$

[edit] See also

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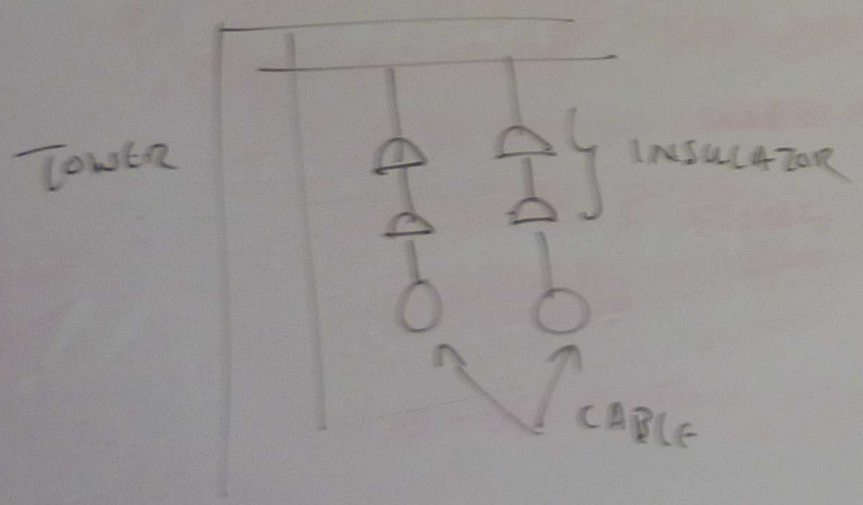
DIELECTRIC STRENGTH

- OF AN INSULATING MATERIAL, THE MAXIMUM DIELECTRIC FIELD STRENGTH THAT IT CAN WITHSTAND INTRINSICALLY WITHOUT BREAKING DOWN

Q19 BRIEFLY EXPLAIN TRANSMISSION LINE INSULATION.



PIN, SUSPENSION INSULATOR STRINGS PREVENT THE ELECTRICAL CURRENT FLOW IN CONDUCTORS NOT TO REACH THE TOWER FRAME.

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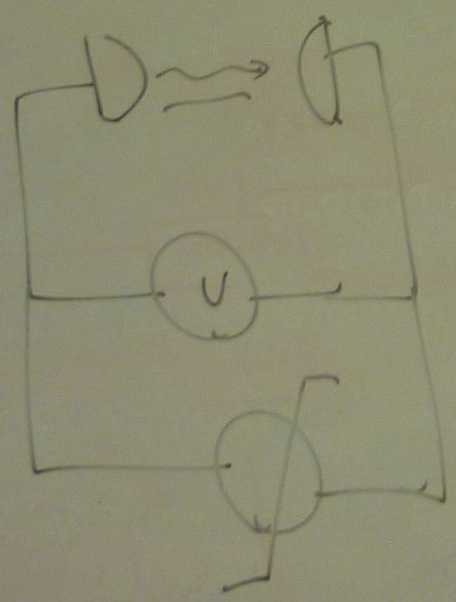
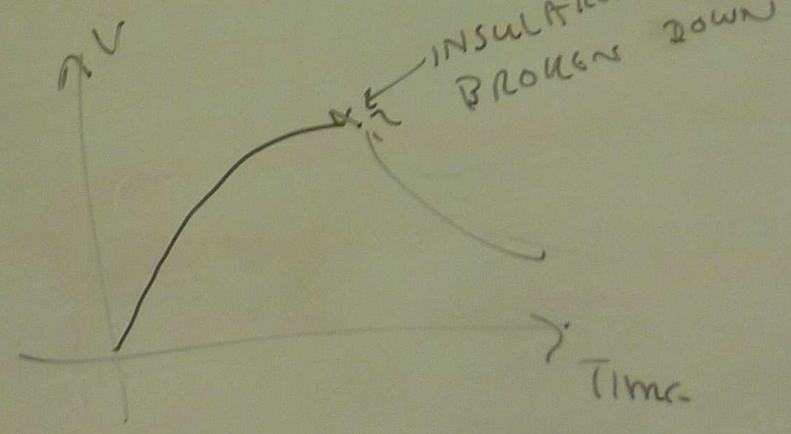
Q20. DESCRIBE INSULATION BREAK DOWN.

WHEN THE EXTERNAL FIELD STRENGTH IS TOO HIGH THE DIELECTRIC STRENGTH IS BROKEN DOWN AND ELECTRICAL CURRENT WILL FLOW THROUGH THE INSULATOR.

Q21 EXPLAIN VOLT TIME CHARACTERISTICS OF BREAK DOWN.





— MAKE A SMALL HOLE

— SLOWLY INCREASE THE

— PLOT THE TIME &

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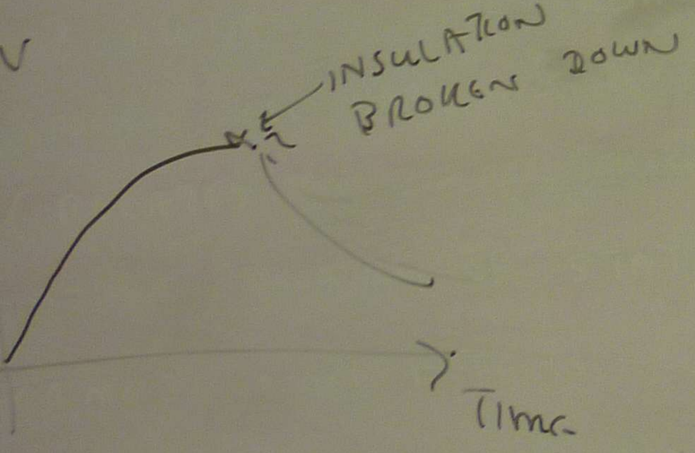

— MAKE A SMALL HOLE IN TEST PIECE

— SLOWLY INCREASE THE VOLTAGE

— PLOT THE TIME & AMOUNT OF
VOLTAGE GIVEN TO TEST PIECE
UNTIL IT IS BROKEN DOWN.

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strength of 5000 V /mm. Again the test voltage is calculated to be 11,180 V but now the breakdown voltage of the material is 10,000 Volts (2 x 5000). This is clearly less than our test voltage and attempting to use 11,180V to test this coating would result in the creation of more holes.

In this instance high voltage holiday detection may still be used to locate flaws in the coating, but some further testing is required to ensure that this method is valid.

Referring to the example above of a 2mm coating with a dielectric strength of 5000 V / mm, the validation test would be as follows:

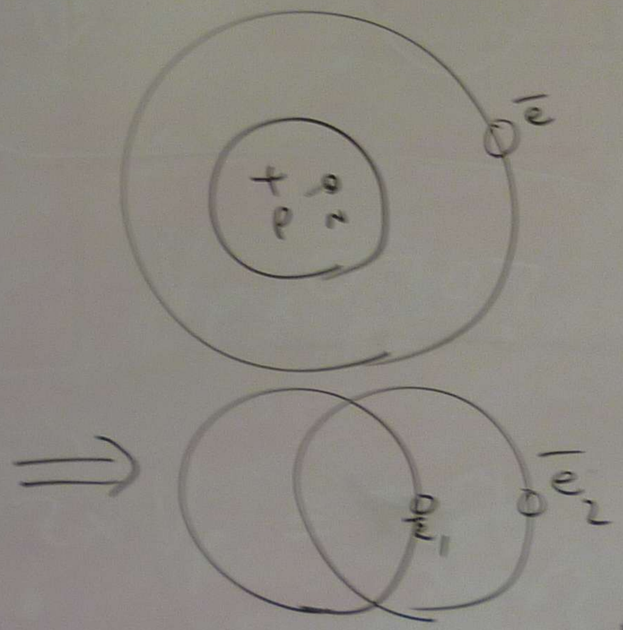
1. Make a small hole in a test piece.
2. With the electrode over the hole slowly increase the voltage until the spark jumps the gap. Note the voltage (which in this instance, on a 2mm coating, would be ~ 5000 V).
3. To determine the test voltage, use a value midway between the test voltage calculated using the NACE formula (in this case 11,180 V) and the minimum voltage determined from the above test (~5000V). This works out to be 8090 V. ((11,180 – 5000) / 2) +5000).
4. Now make some more holes in the test piece (making sure there is more than 20mm between each hole), this time at angles, and using your test voltage (in our example 8090V) ensure that it is possible to locate the faults.

This method of finding the test voltage is fine if all you are looking for is cracks in the coating (that is complete faults that go all the way through the coating to the substrate). Indeed, many standards only require this type of fault to be detected. However, with

Q22 SKETCH

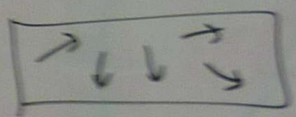
(a) ELECTRONIC POLARIZATION (b) IONIC POLARIZATION (c) ORIENTAL POLARIZATION

(a)



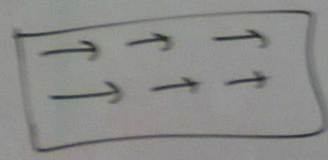
(b)

(c)



NO MAGNETIC EFFECT

MAGNETIC FIELD



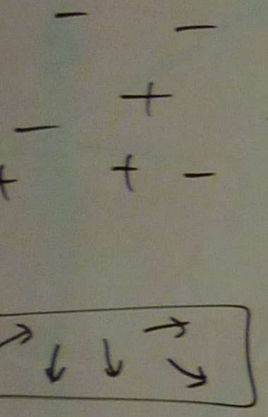
ORIENTAL POLARIZATION

Q29

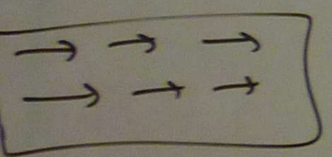
Q30

Q31

(c) ORIENTAL POLARIZATION



NO MAGNETIC EFFECT



ORIENTAL POLARIZATION

Q29 DESCRIBE ELECTRONIC POLARIZATION

Q30 DESCRIBE IONIC POLARIZATION

Q31 DESCRIBE ORIENTAL POLARIZATION

Q29 DUE TO ELECTRIC FIELD, THE ORBIT OF ELECTRON SHIFTS TO NEW ORBIT

Q30 DUE TO ELECTRON MOVING OUT FROM ATOM, + HOLES AND − ELECTRONS APPEAR IN ATOM

Q31 DUE TO MAGNETIC FIELD, THE MAGNETIC PARTICLES IN DIFFERENT DIRECTIONS ALIGN TO PARTICULAR DIRECTION AND THE MATERIAL POSSESSES THE MAGNETISM.

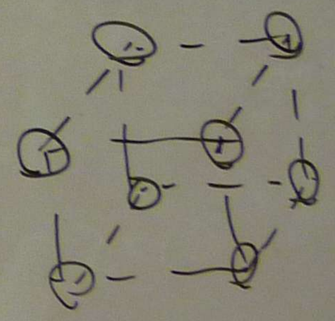
Q24 EXPLAIN ORGANIC

ORGANIC COMPOUNDS BASIC AND CAN BE ORGANIC COMPOUNDS DIELECTRIC MATERIALS.

Q25 SKETCH THE

(a) SIMPLE CUBIC LATTICE (c)

(a) (b)



CLARIZATION

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AGNETISM.

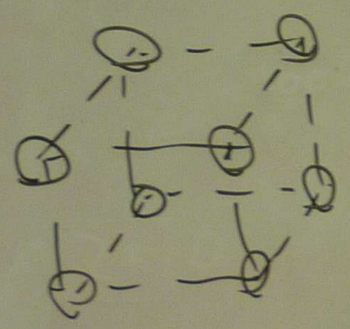
Q24 EXPLAIN ORGANIC COMPOUNDS.

ORGANIC COMPOUNDS CONSIST OF CARBON AND HYDROGEN AS BASIC AND CAN BE COMPOUNDED WITH FLUORINE ETC. ORGANIC COMPOUNDS ARE APPLIED TO MAKE INSULATION AND DIELECTRIC MATERIALS.

Q25 SKETCH THE FOLLOWINGS

(a) SIMPLE CUBIC LATTICE (b) FACE CENTRED CUBIC LATTICE (c) BODY CENTRED LATTICE.

(a)



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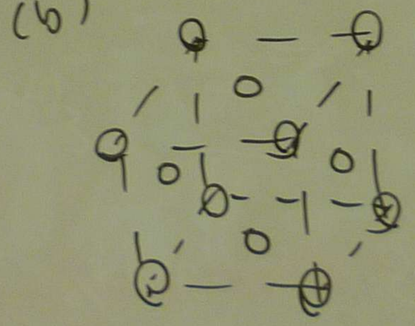

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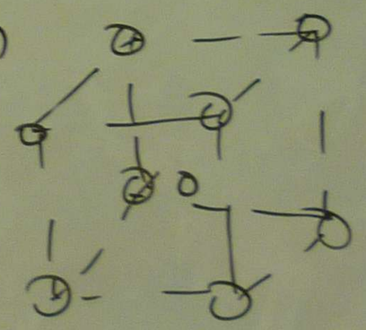
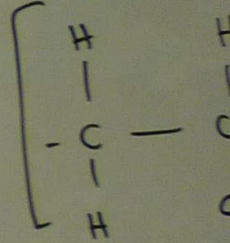


Q26 EXPRESS
OF
(a) POLY VINYL

(a) POLY VINY



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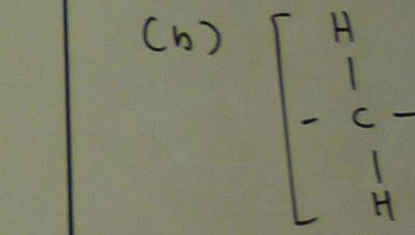
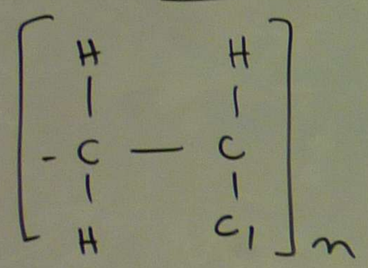


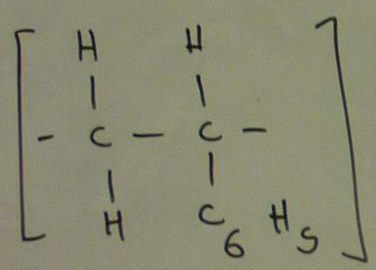
Q26 EXPRESS THE CHEMICAL STRUCTURE of

(a) POLY VINYL CHLORIDE (b) POLYSTYRANE

(a) POLY VINYL CHLORIDE



(b)



POLYSTYRANE

REFERENCE NOTES

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E081 MATERIAL SCIENCE

✓ T6 NON METALLIC MATERIALS (ppt)

✓ T3 CONDUCTORS & SEMI CONDUCTOR

✓ T4 CHEMICAL EFFECT ON MATERIALS

L CORROSION PROTECTION

T7 MANUFACTURING PROCESS & MATERIALS

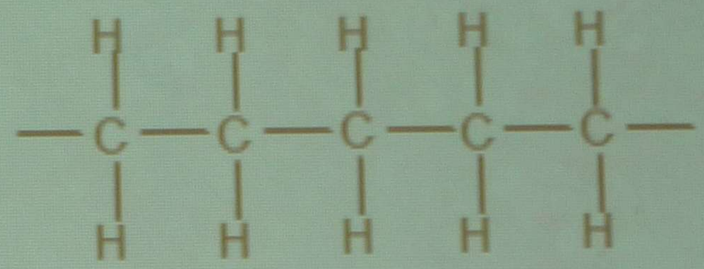
TEXT BOOK

PAGE 7 → 13

Properties of polymers

Chemical Composition

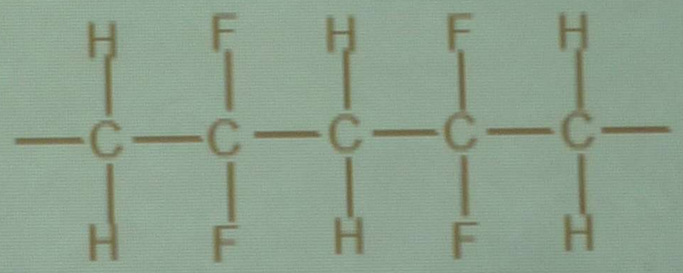
soft to hard, unbreakable, (MWTM)



Polyethylen (PE)

weich bis hart, unzerbrechlich, löslich in einer Vielzahl von Lösungsmitteln (MWTM)

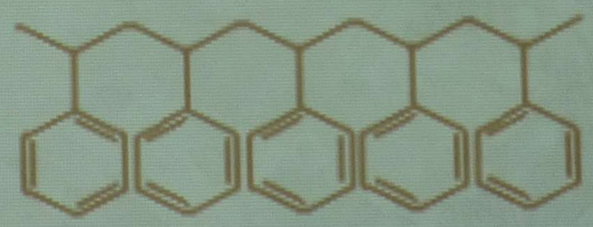
hard, tough, unbreakable, superior chemical resistivity (OBTF)



Polyvinylidenflourid (PVDF)

hart, zäh, unzerbrechlich, hervorragende chem. Beständigkeit (OBTF)

hard, breakable, (plastic spoons and forks, joghurtbeaker)

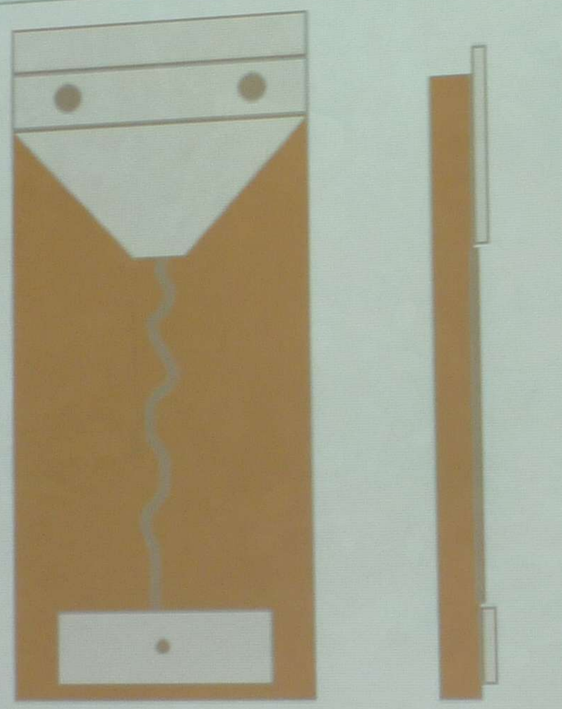


Polystyrol (PS)

hart, zerbrechlich (z.B. Geodreiecke, Joghurtbecher, Wegwerfbestecke)

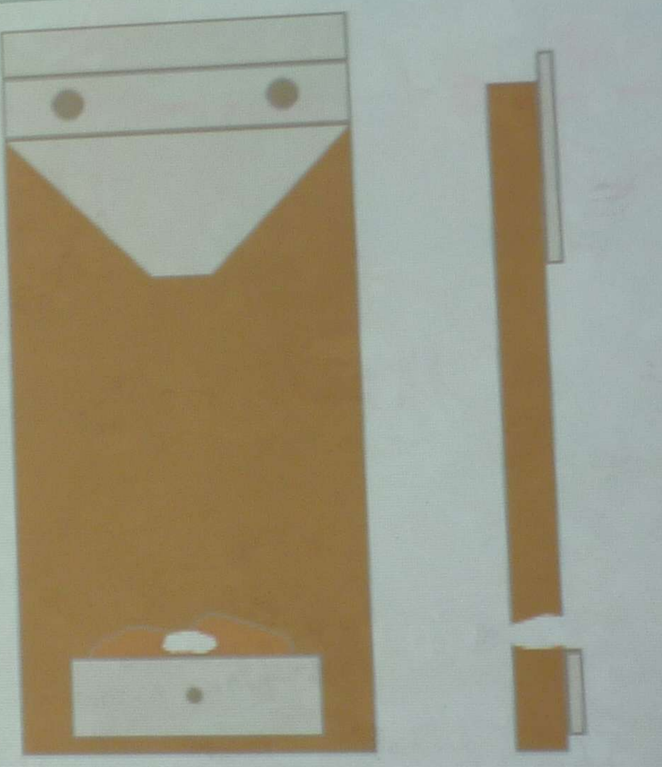
tyco Electronics

TERT - Key Failure Mechanisms



Sample - Front View Side View

Tracking failure
(rapid process)



Sample - Front View Side View

Erosion failure
(slow process)

tyco Electronics

C_2H_4

C_5H_4

C_5F_4

Anti-Tracking Properties Through Aluminium Tri Hydrate

1. Chemical action:

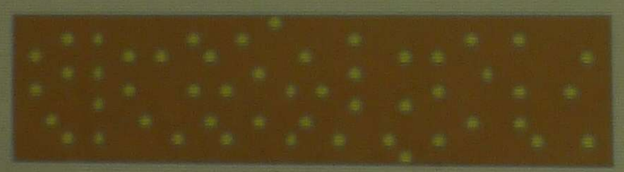
$$Al_2O_3.3H_2O + 3C \downarrow 3CO + Al_2O_3 + 3H_2$$

2. Physical action:

$Al_2O_3.3H_2O \longrightarrow$ Steam

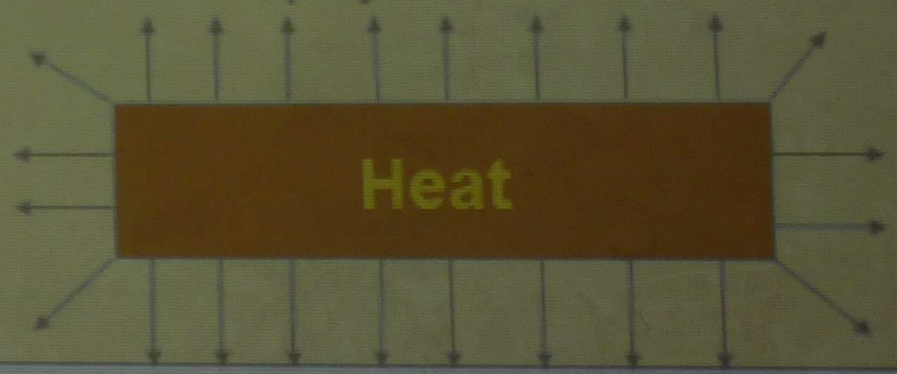
3. Volume effect

The amount of fuel (polymer) is reduced by adding ALTH



4. Thermal effect

Endothermic reaction keeps polymer cool



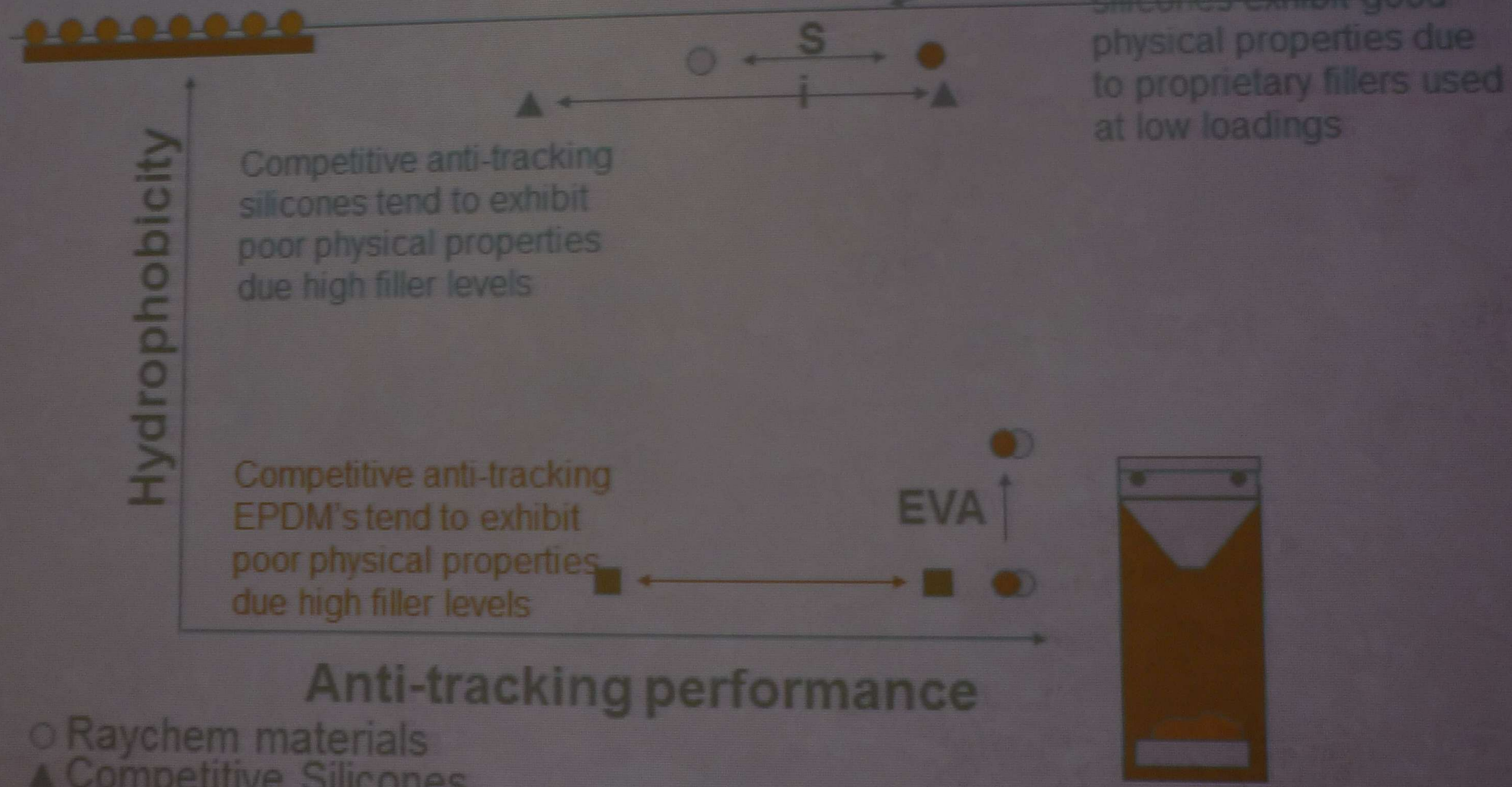
Mechanism Of Iron Oxide

Iron oxide acts as a UV screen and an additional catalyst for oxidation of the char (anti-tracking properties) in silicone materials

Examples of reaction;

$$Fe_2O_3 + C \longrightarrow 2FeO + CO$$
$$Fe + O_2 + 2C \longrightarrow Fe + 2CO$$
$$3Fe + C \longrightarrow Fe_3C$$
$$Fe_2O_3 + 3C \longrightarrow 2Fe + 3CO$$
$$Fe_2O_3 + 11C \longrightarrow 2Fe_3C + 9CO$$

Material Comparison



Base Polymer Tracking Resistance

In general conduction (tracking) is facilitated by a combination of the following factors :

- Chain formation
- Aromaticity
- Conjugation
- Ionic Charge Centers
- Interaction Of Adjacent Charged Zones

Q26

EXPLAIN COVALENT BONDING

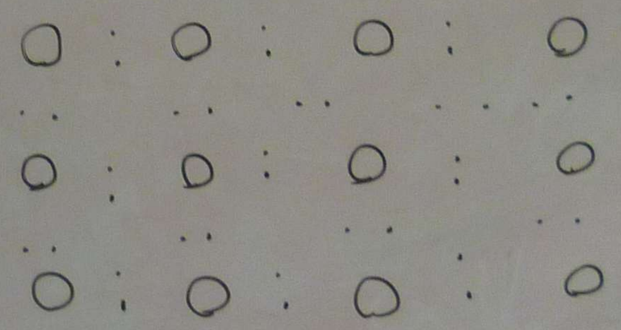
Q27.

EXPLAIN ATOMIC STRUCTURE of METAL

Q28

WHAT IS CRYSTAL?

Q26



THE REPULSIVE FORCE DUE TO OVERLAP OF ELECTRON SHELL FINALLY OVERCOMES ATTRACTIVE FORCE AND THE CRYSTAL FORMS WITH AN ATOMIC SPACING

CORRESPONDING TO MINIMUM E

THE ENERGY CURVES ARE SIMI

FOR IONIC CRYSTAL.

CARBON, GERMANIUM AND

COVALENT CRYSTALS.

Q27

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AND THE CRYSTAL FORMS
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CORRESPONDING TO MINIMUM ENERGY FOR CRYSTAL.
THE ENERGY CURVES ARE SIMILAR TO THOSE SHOWN
FOR IONIC CRYSTAL.
CARBON, GERMANIUM AND SILICON ARE IMPORTANT
COVALENT CRYSTALS.

Q27 IN METAL, THE VALANCE (OUTER MOST) ELECTRONS
ARE SHARED BY ALL ATOMS, THIS TAKES THEM
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VALANCE ELECTRONS.
COPPER, SILVER, GOLD
NICKELS ARE THIS
CRYSTALS

Q28 THE CRYSTAL
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TWO POINTS
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IONS AND NEGATIVE CHARGE DISTRIBUTION CORRESPONDING TO VALANCE ELECTRONS.

COPPER, SILVER, GOLD, ALUMINIUM NICKELS ARE THIS TYPE OF CRYSTALS

Q 28 THE CRYSTAL STRUCTURE IS BASED ON THE FOLLOWING TWO POINTS

(a) THE UNIT SHELL WHICH IS THE SMALLEST ELEMENT OF CRYSTAL LATTICE OUT OF WHICH THE ENTIRE CRYSTAL MAY BE FORMED BY REPEATITION OF THE UNIT CELLS.

(b) THE LATTICE CONSTANT WHICH IS THE LENGTH OF THE UNIT CELL ALONG ONE OF IT'S EDGES.

CHEMICAL EFFECT ON MATERIALS

CHEMICAL IMPACTS ⟶ MATERIAL CORROSION

NON METALLIC MATERIALS SLIDE 68 ⟶ 73

Q49 EXPLAIN CHEMICAL REACTION INSIDE ELECTRIC CELL.

Q50 EXPLAIN CORROSION

Q51 DESCRIBE THE FOLLOWINGS
(a) GALUANIC CORROSION (b) CORROSION REMOVAL
(c) RESISTANCE

Q52 WRITE THE WAYS TO PROTECT CORROSION.

Q53 WHAT ARE THE forms of corrosion.

Q49

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MATERIALS

IAL CORROSION

DE G8 → 73

ON INSIDE ELECTRIC CELL.

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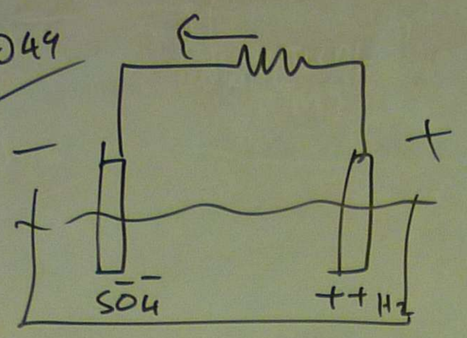
ON (6) CORROSION REMOVAL

PROTECT CORROSION.

S OF CORROSION.

Q49



H_2SO_4

SPECIAL CHEMICAL REACTION WHICH OCCUR INSIDE THE ELECTRIC CELL RESULT IN OXIDATION AND REDUCTION OF THE SUBSTANCES INSIDE THE CELL THIS PRODUCES ELECTRICAL ENERGY. NORMAL BATTERIES WORK LIKE THIS

Q50 CORROSION IS THE GRADUAL DESTRUCTION OF MATERIALS USUALLY METALS BY CHEMICAL REACTION WITH IT'S ENVIRONMENT.

THIS MEANS ELECTRO-CHEMICAL OXIDATION OF METALS IN REACTION WITH OXIDANT SUCH AS OXYGEN. RUSTING, FORMATION OF IRON OXIDE IS A WELL KNOWN EXAMPLE OF OXIDATION.

REFERENCE NOTES

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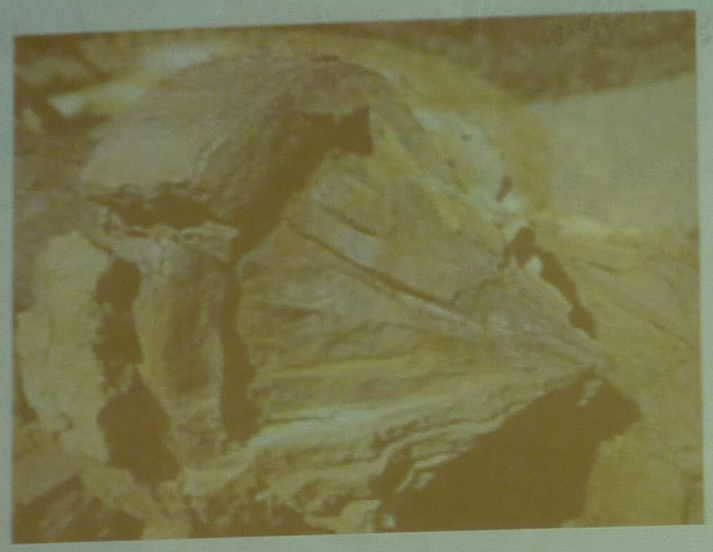
T7 MANUFACTURING PROC

TEXT

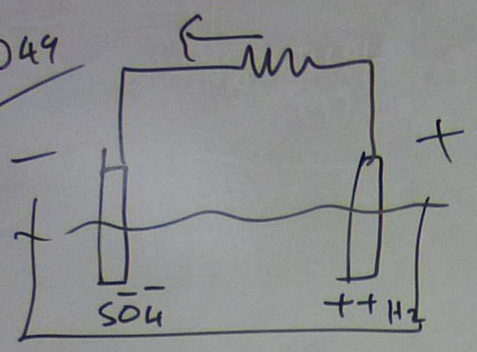
PAGE

Rust, the most familiar example of corrosion.



Volcanic gases have accelerated the corrosion of this abandoned mining machinery.

Q49



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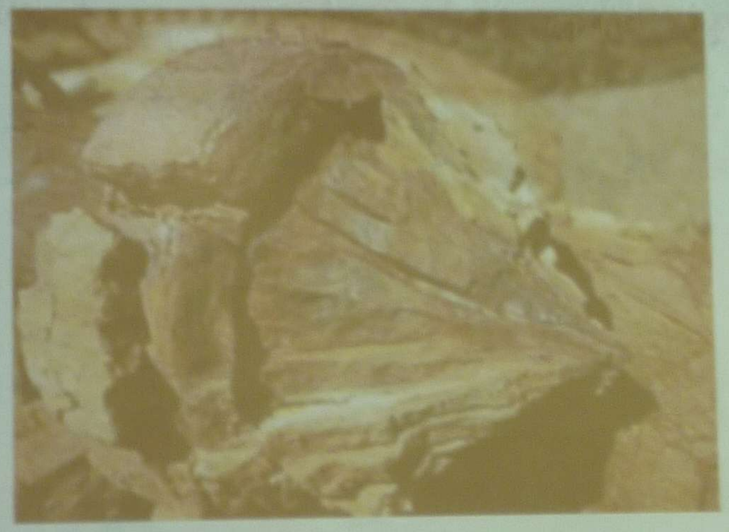
└ CORROSION

T7 MANUFACTURING PROCESS & MATE

TEXT BOOK
PAGE 7 → 13



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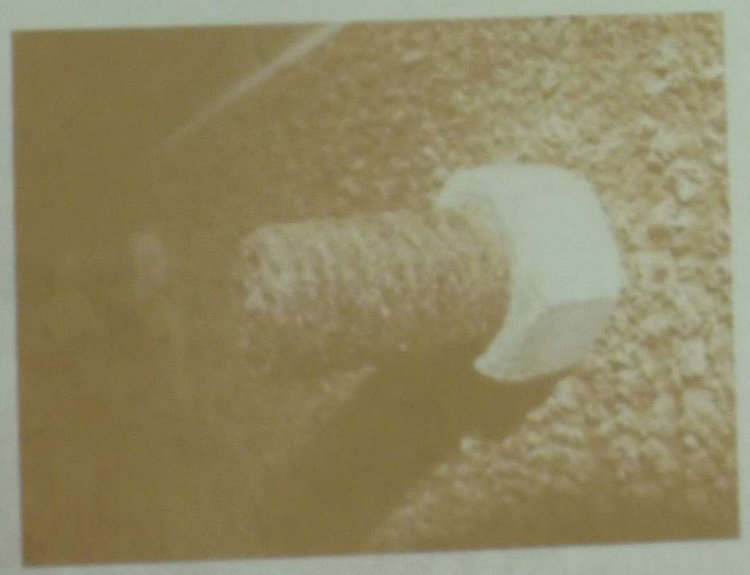
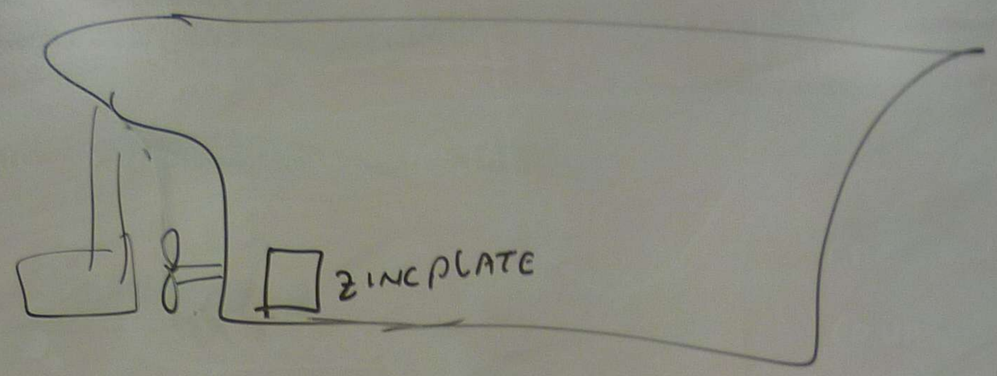




6 51 (a) GALVANIC CORROSION OCCURS WHEN TWO DIFFERENT METALS HAVE PHYSICAL (OR) ELECTRICAL CONTACT WITH EACH OTHER AND ARE IMMERSED IN A COMMON ELECTROLYTE, OR WHEN THE SAME METAL IS EXPOSED TO ELECTROLYTE WITH DIFFERENT CONCENTRATIONS.

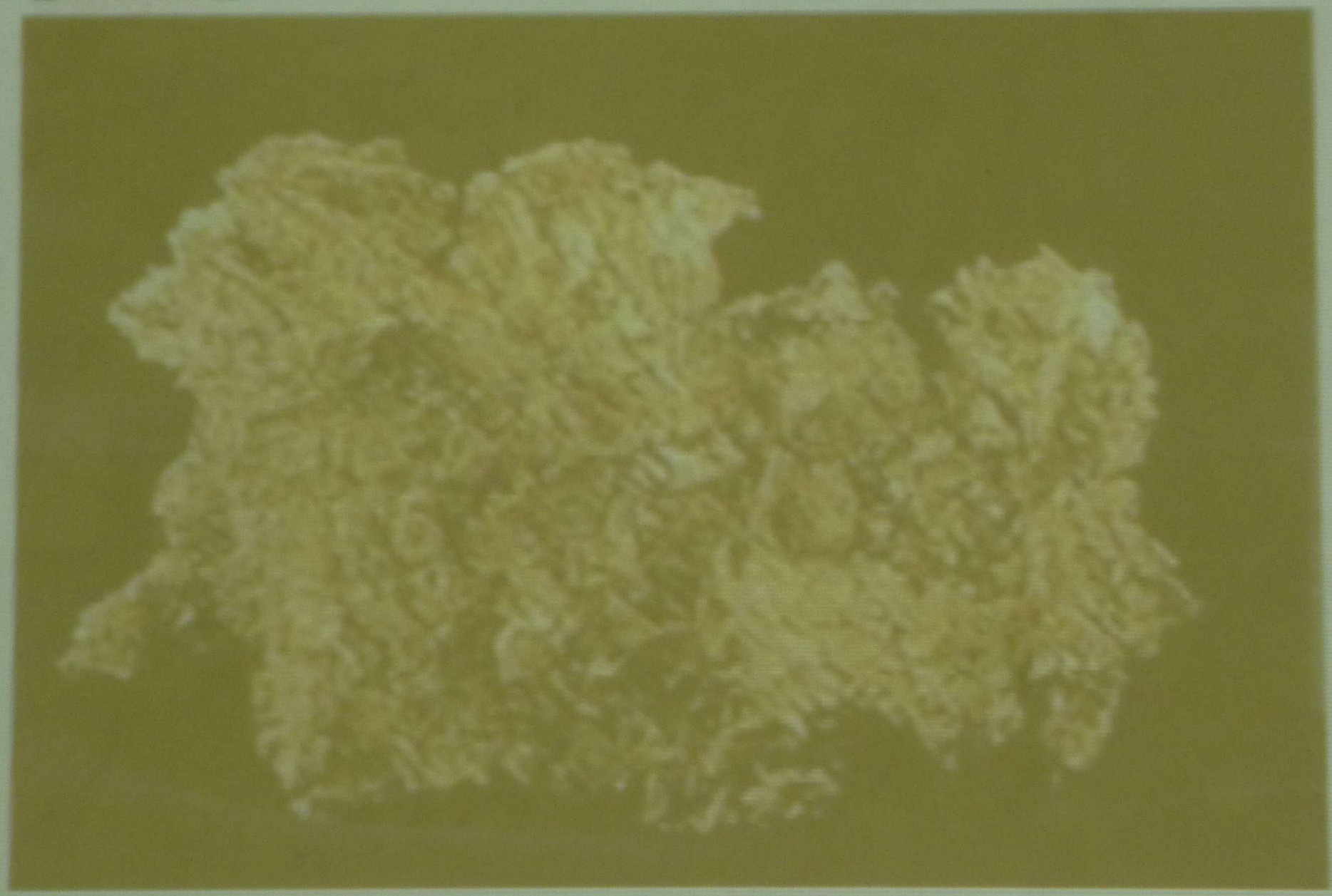
IN A GALVANIC COUPLE, THE MORE ACTIVE METAL (THE ANODE) CORRODES AT AN ACCELERATE RATE AND THE MORE NOBLE METAL (THE CATHODE) CORRODES AT A RETARDED RATE.

- 10.2.1 Glass corrosion tests
- 11 See also
- 12 References
- 13 Further reading
- 14 External links

[edit] Galvanic corrosion

Main article: Galvanic corrosion

[edit] Intrinsic chemistry



Q51(b) IT IS POSSIBLE TO CHEMICALLY REMOVE THE PRODUCTS OF CORROSION. FOR EXAMPLE, PHOSPHORIC ACID IN THE FORM OF NAVAL JELLY IS OFTEN APPLIED TO FERROUS TOOLS (OR) SURFACES TO REMOVE RUST.

(b)

Q51(c) SOME METALS ARE MORE INTRINSICALLY RESISTANT TO CORROSION THAN OTHERS. THERE ARE VARIOUS WAYS OF PROTECTING METALS FROM CORROSION INCLUDING PAINTING, HOT DIP GALVANIZING AND COMBINATION OF THESE.

Q

WHEN TWO
AL (OR) ELECTRICAL
ARE IMMERSED
WHEN THE SAME
IS WITH DIFFERENT

ORE ACTIVE METAL
ACCELERATE RATE
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RATE.

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Q52
- REACTING COATING
- ANODIZATION
- BIO FILM COATING
- CATHODIC PROTECTION
- SACRIFICIAL ANODE PROTECTION
- IMPRESSED CURRENT CATHODIC PROTECTION.

CHE

Q49

Q50

Q51

Q52

Base Polymer Tracking Resistance

	Dust-Fog (hours)
Polyvinyl chloride	0.3
Polystyrene	0.9
Polyvinyl acetate	1
Polyethylene	33
Poly methyl methacrylate	162
Polytetrafluoroethylene	600

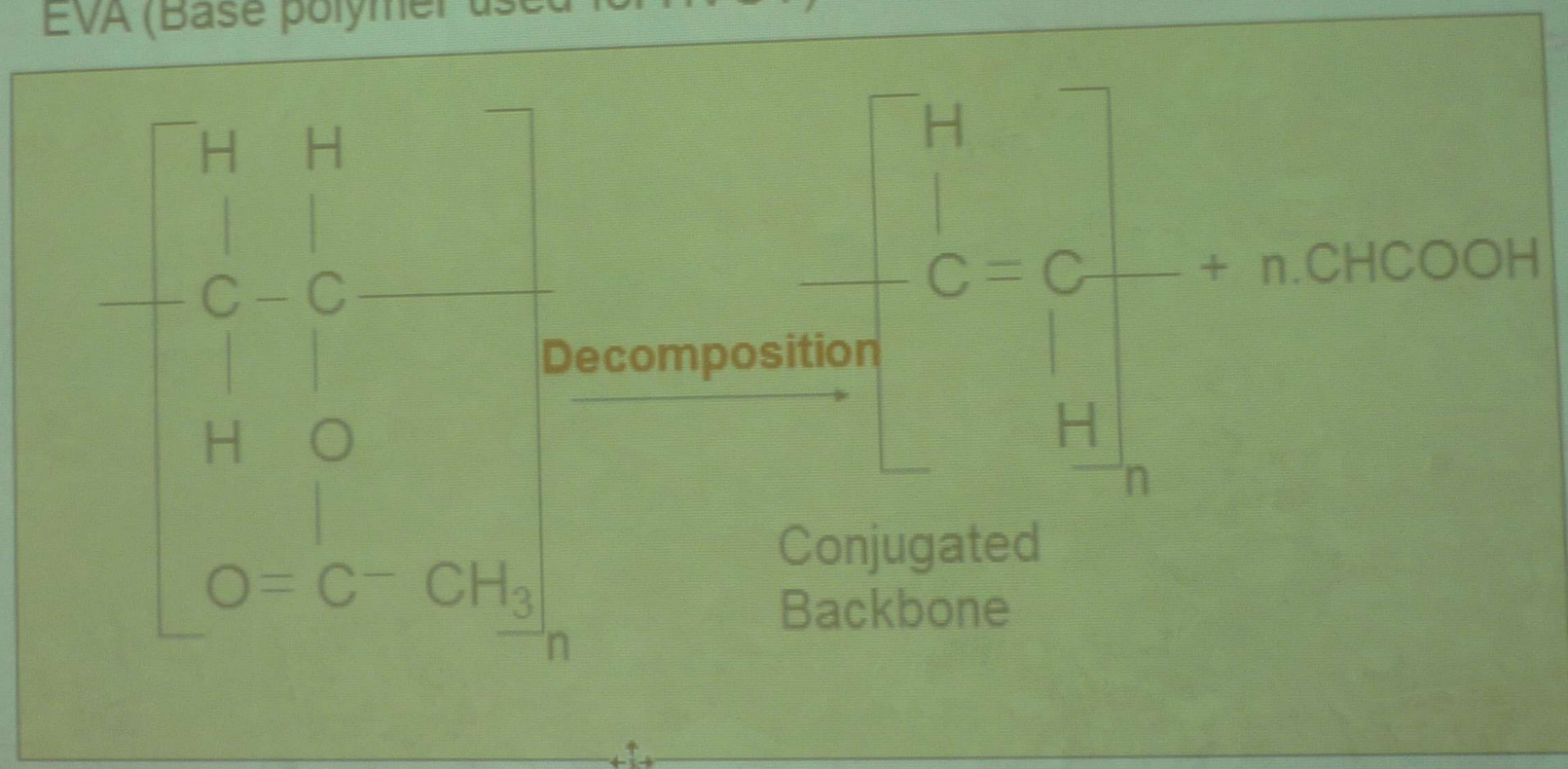
Tracking performance is associated with a materials tendency to form a conductive char residue on decomposition.

tyco Electronics

Click to add notes

Example Of A Track Prone Polymer

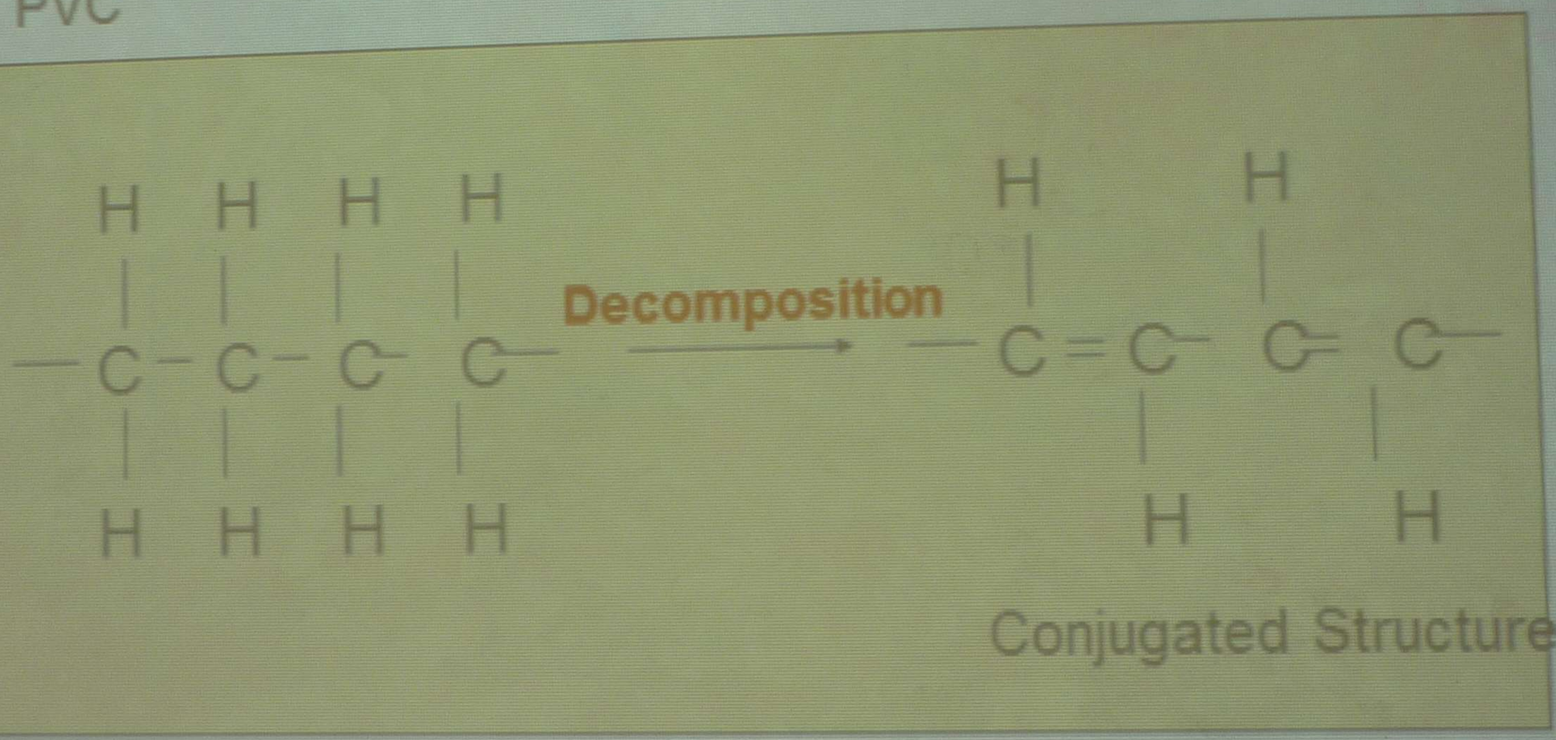
EVA (Base polymer used for HVOT)



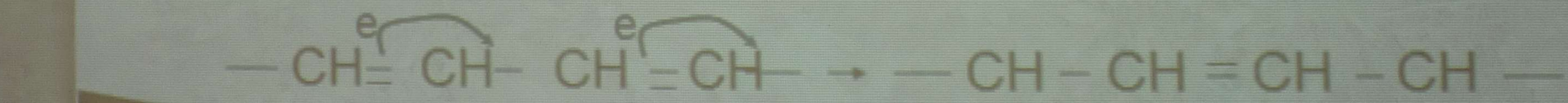
notes

Example Of A Track Prone Polymer

PVC



Conduction occurs via electron transfer :



tyco Electronics

Materials.ppt [Compatibility Mode] - Microsoft PowerPoint

Design Transitions Animations Slide Show Review View Adobe Presenter Acrobat

Layout Reset Section — Font — Paragraph — Text Direction Align Text Convert to SmartArt — Drawing — Arrange Quick Styles Shape Fill Shape Outline Shape Effects — Find Replace Select — Editing

Polymer / Elastomer Base

Polymers

Elastomers

Fillers

Anti-Tracking Fillers

Carbon Blacks

Other Fillers

The Magic Dust!!

Special / Proprietary Additives

Example - Semi-conductive (Stress grading)

JSCR

Cross-linking Agents

Peroxide

Prorad

Additives

Iron Oxide

Thermal Stabilisers

UV Stabilisers

Process Aids

Oils

tyco Electronics

add notes

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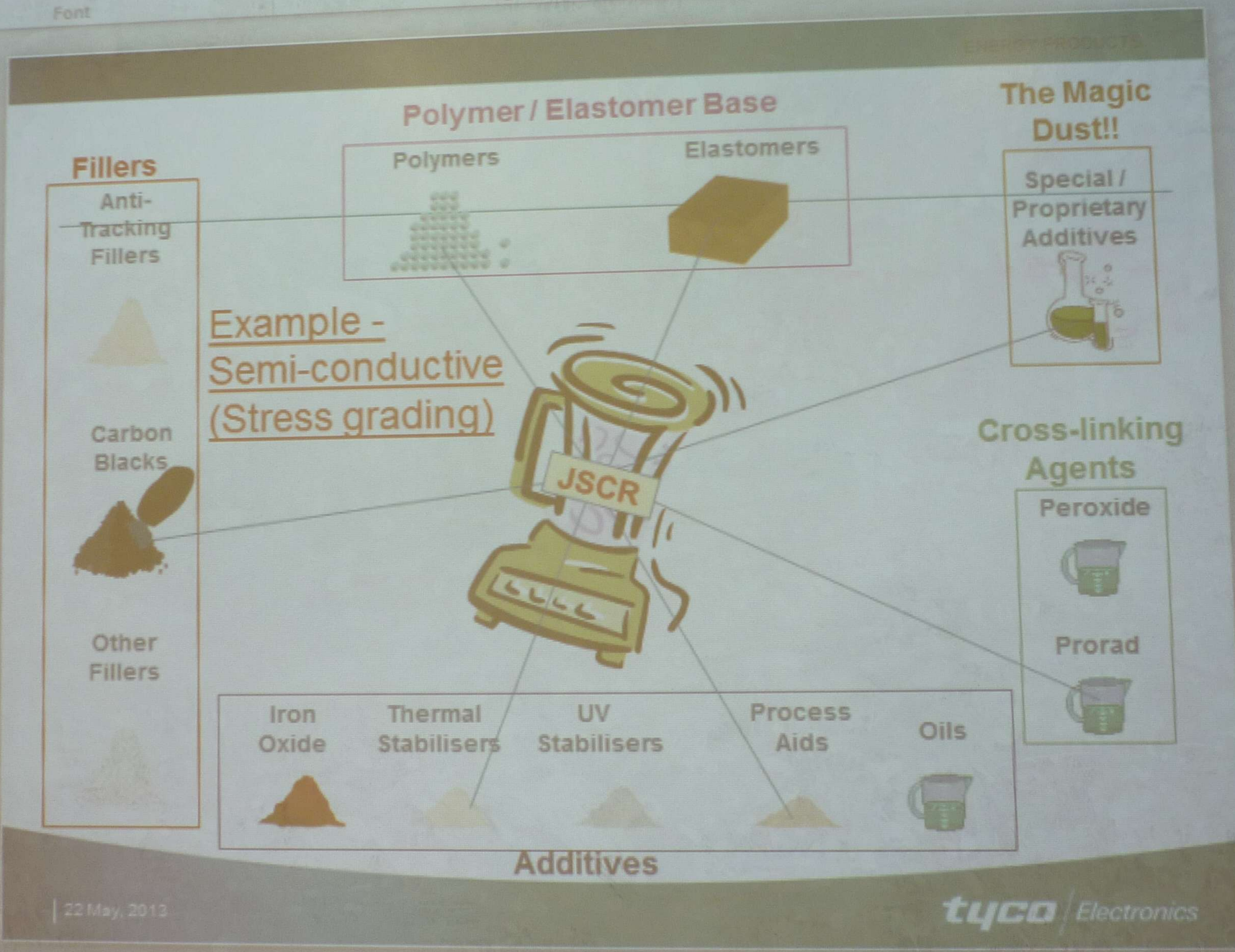


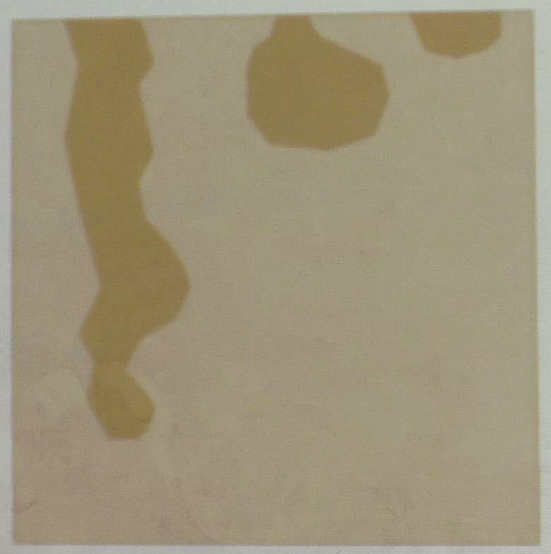
Click to add notes

[edit] Corrosion in passivated materials

Passivation is extremely useful in mitigating corrosion damage, however even a high-quality alloy will corrode if its ability to form a passivating film is hindered. Proper selection of the right grade of material for the specific environment is important for the long-lasting performance of this group of materials. If breakdown occurs in the passive film due to chemical or mechanical factors, the resulting major modes of corrosion may include pitting corrosion, crevice corrosion and stress corrosion cracking.

[edit] Pitting corrosion

Main article: Pitting corrosion



The scheme of pitting corrosion

its name implies, corrosion is limited to a very narrow zone adjacent to the weld, often only a few micrometers across, making it even less noticeable.

[edit] Crevice corrosion

Main article: Crevice corrosion

Corrosion in the crevice between the tube and tube sheet (both made of type-316 stainless steel) of a heat exchanger in a seawater desalination plant.[4]

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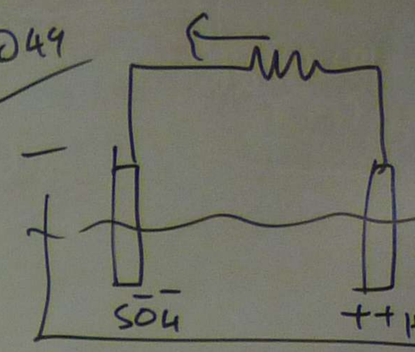
BASE POLYMER TRACKING RESISTANCE

Q53

- PITTING CORROSION
- CREVICE CORROSION
- MICROBIAL CORROSION
- HIGH TEMPERATURE CORROSION
- METAL DUSTING

Q49



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CRACKING

FOLLOWINGS

: STEEL (c) ALUMINIUM

@54

STRESS CORROSION CRACKING (SCC) IS CAUSED BY THE SIMULTANEOUS EFFECTS of TENSILE STRESS AND A SPECIFIC CORROSIVE ENVIRONMENT. STRESSES MAY BE DUE TO APPLIED LOADS. RESIDUAL STRESSES FROM THE MANUFACTURING PROCESS (OR) COMBINATION OF BOTH.

REFERENCE NOTE

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E08(MATERIAL S

✓ T6 NON METALLIC MA

✓ T3 CONDUCTORS &

✓ T4 CHEMICAL EFFE

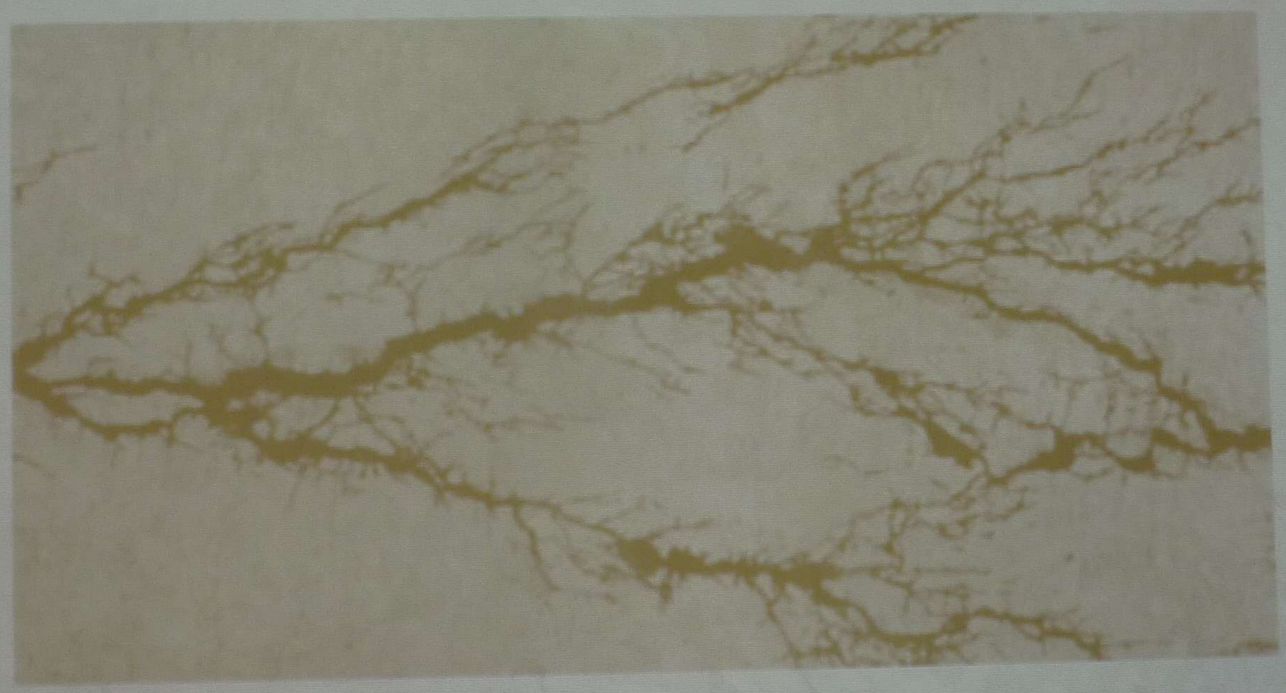
T7 MANUFACTURI

125%
Tools

The picture on the left shows exfoliation of aluminum. Exfoliation of carbon steel is apparent in the channel on the coating exposure panel on the right. The expansion of the metal caused by exfoliation corrosion can create stresses that bend or break connections and lead to structural failure.

Stress Corrosion Cracking

Stress corrosion cracking (SCC) is caused by the simultaneous effects of tensile stress and a specific corrosive environment. Stresses may be due to applied loads, residual stresses from the manufacturing process, or a combination of both.



Cross sections of SCC frequently show branched cracks. This river branching pattern is unique to SCC and is used in failure analysis to identify when this form of corrosion has occurred.

The photo below shows SCC of an insulated stainless-steel condensate line. Water wetted the

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INTRINSICALLY RESISTANT TO
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ROSION INCLUDING PAINTING,
OMBINATION OF THESE.

- SACRIFICIAL ANODE PROTECTION
- IMPRESSED CURRENT CATHODIC PROTECTION.

BASE POLYMER TRACKING RESISTANCE

Q53
- PITTING CORROSION
- CREVICE CORROSION
- MICROBIAL CORROSION
- HIGH TEMPERATURE CORROSION
- METAL DUSTING

Q54 EXPRESS STRESS CORROSION CRACKING

Q55 WRITE NOTES FOR THE FOLLOWINGS
(a) CARBON STEEL (b) STAINLESS STEEL (c) ALUMINIUM
(d) COPPER ALLOY.

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STRESS CORROSION CRACKING (SCC) IS CAUSED BY THE SIMULTANEOUS EFFECTS of TENSILE STRESS AND A SPECIFIC CORROSIVE ENVIRONMENT. STRESSES MAY BE DUE TO APPLIED LOADS. RESIDUAL STRESSES FROM THE MANUFACTURING PROCESS (OR) COMBINATION OF BOTH.

Q55 (a) CARBON STEEL

MOST LARGE METAL STRUCTURES ARE MADE FROM CARBON STEEL MIXING THE STEEL WITH APPROPRIATE CARBON CONTENT, CORROSION PROTECTION CAPABILITY CAN BE ACHIEVED.

SOME FORMS OF CARBON STEELS ARE SUBJECT TO SPECIAL TYPES OF CORROSION SUCH AS HYDROGEN EMBRITTLEMENT

- PROTECTIVE COATING, CATHODIC PROTECTION AND CORROSION INHIBITORS ARE ALL EXTENSIVELY USED TO PROLONG THE LIFE of CARBON STEEL STRUCTURES

(b) STAINLESS STEELS ARE BASED ON THE FORMULA OF IRON WITH 18 % CHROMIUM AND 8 %. NICKEL. THEY ARE IMMUNE TO CORROSION BUT STAINLESS STEELS ARE SUBJECT TO PITTING, CREVICE CORROSION AND STRESS CORROSION CRACKING

(c) - FAVOURABLE STRENGTH TO WEIGHT RATIO
- AERO SPACE APPLICATION

(d) BRASSES AND BRONZES ARE COMMONLY
BRASSES: COPPER + ZINC
BRONZES: COPPER + TIN

USED FOR VALVES AND FITTINGS BUT THEY CAN FACE STRESS CORROSION CRACKING IN THE PRESENCE of AMMONIA compound.

Q54

STRESS CORROSION CRACKING (SCC) IS CAUSED BY THE SIMULTANEOUS EFFECTS of TENSILE STRESS AND A SPECIFIC CORROSIVE ENVIRONMENT. STRESSES MAY BE DUE TO APPLIED LOADS. RESIDUAL STRESSES FROM THE MANUFACTURING PROCESS (OR) COMBINATION OF BOTH.

Q55 (a) CARBON STEEL

MOST LARGE METAL STRUCTURES ARE MADE FROM CARBON STEEL MIXING THE STEEL WITH APPROPRIATE CARBON CONTENT, CORROSION PROTECTION CAPABILITY CAN BE ACHIEVED.

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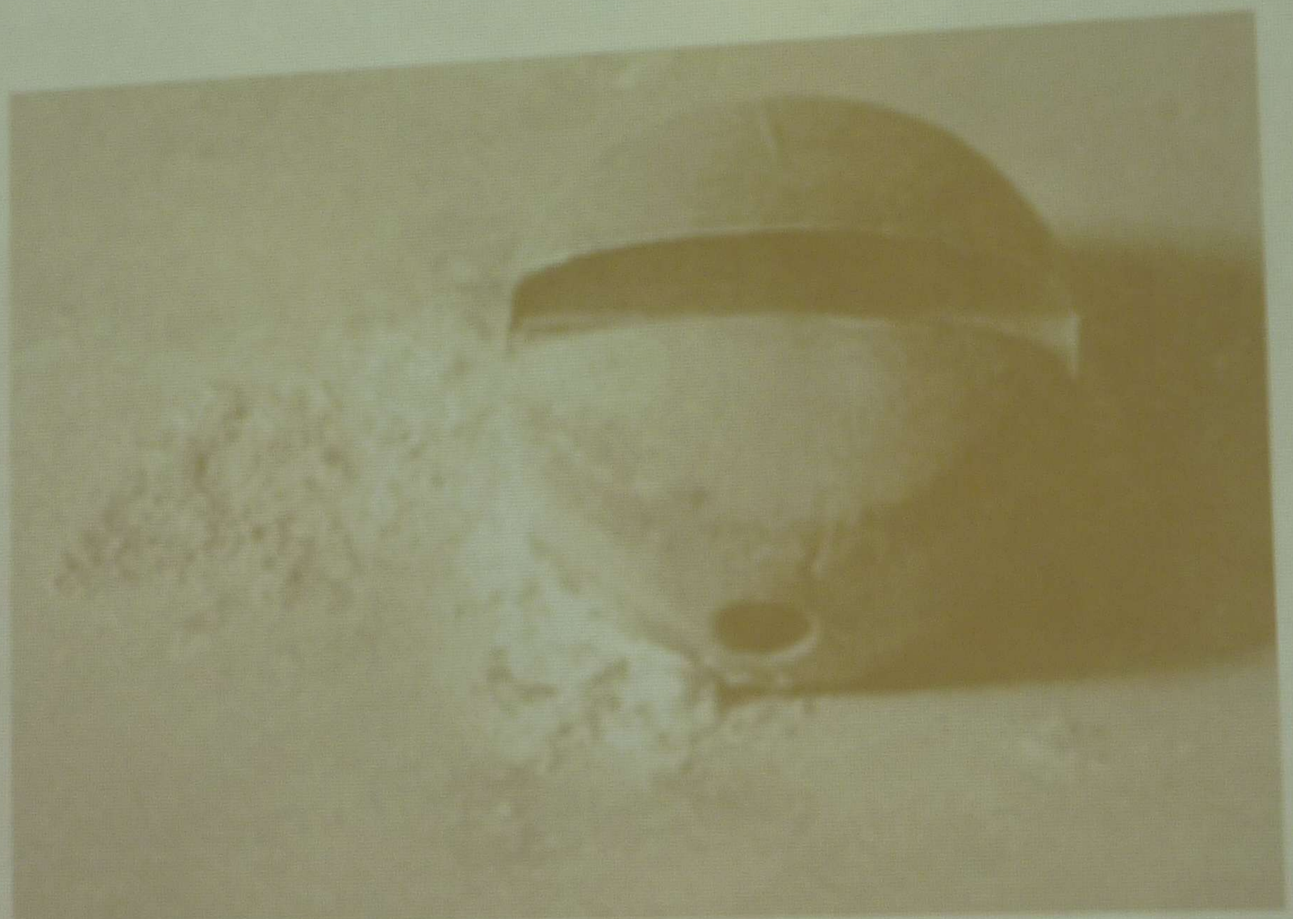
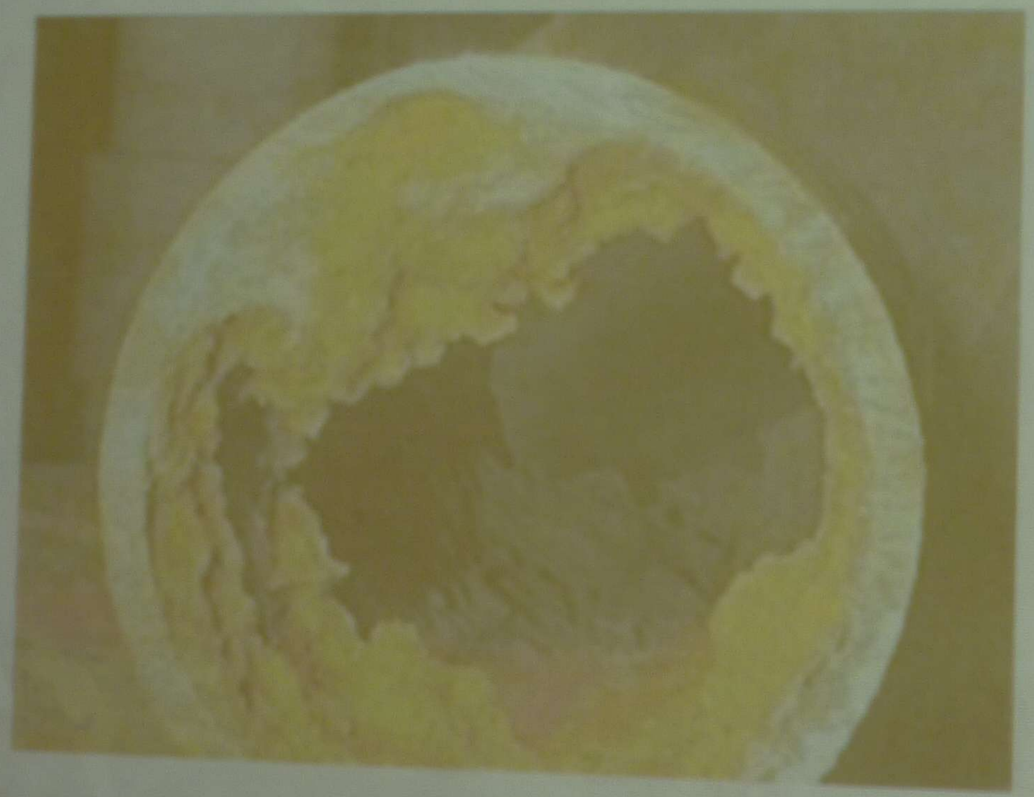
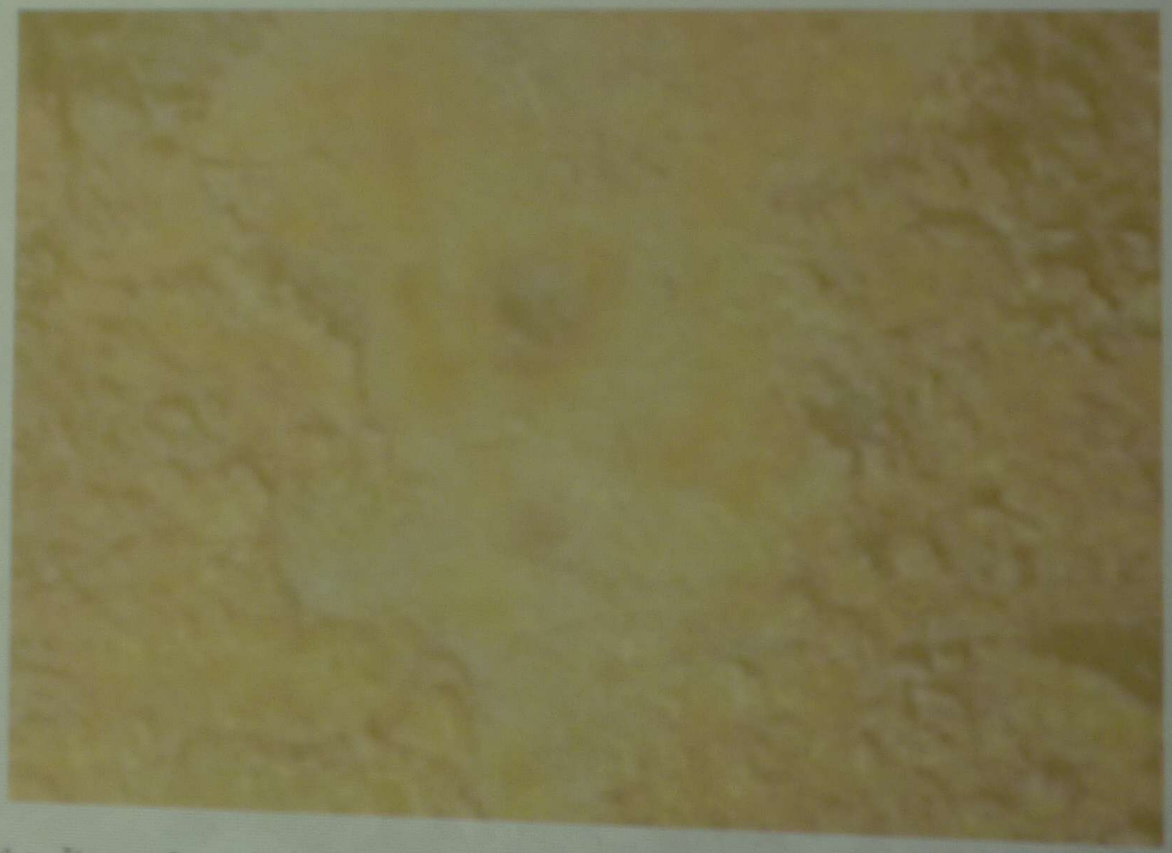


Concentration Cell Corrosion

on cell corrosion occurs when two or more areas of a metal surface are in contact wit
ntrations of the same solution. There are three general types of concentration cell

that can be used to control pitting include maintaining clean surfaces, application of a protective coating, and use of inhibitors or cathodic protection for immersion service. Molybdenum additions to stainless steel (e.g. in 316 stainless) are intended to reduce pitting corrosion.





(Courtesy of www.eci-ndt.com)

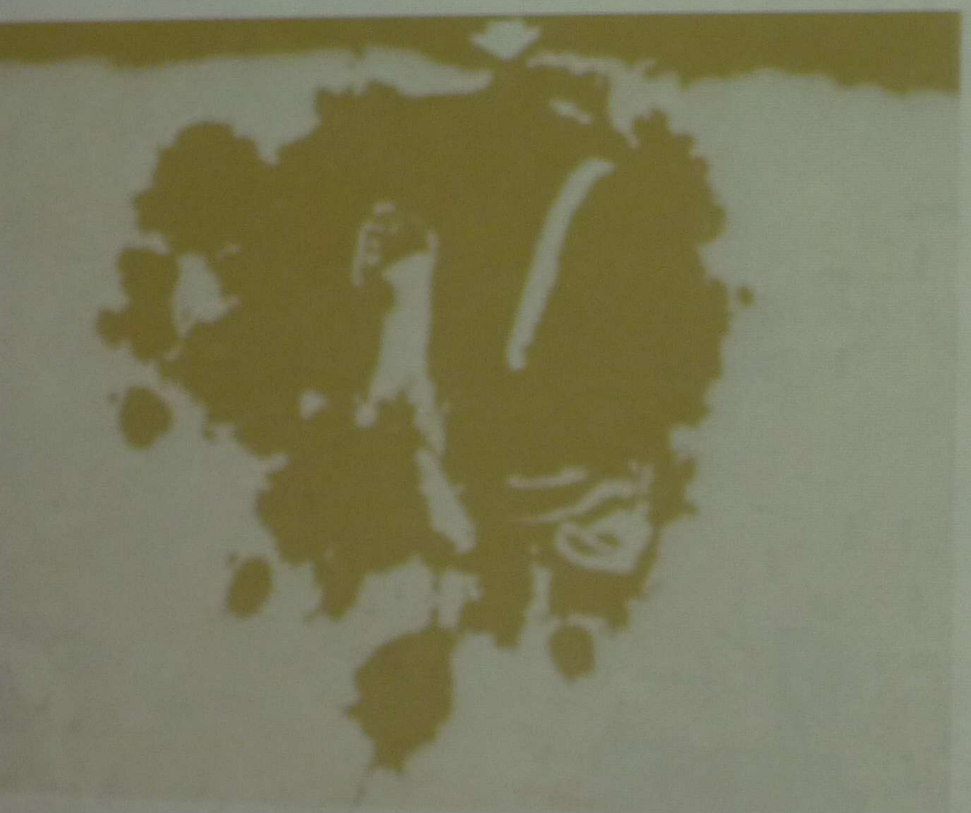
The rust bubbles or tubercules on the cast iron above indicate that pitting is occurring. Researchers have found that the environment inside the rust bubbles is almost always higher in chloride
lower in pH (more acidic) than the

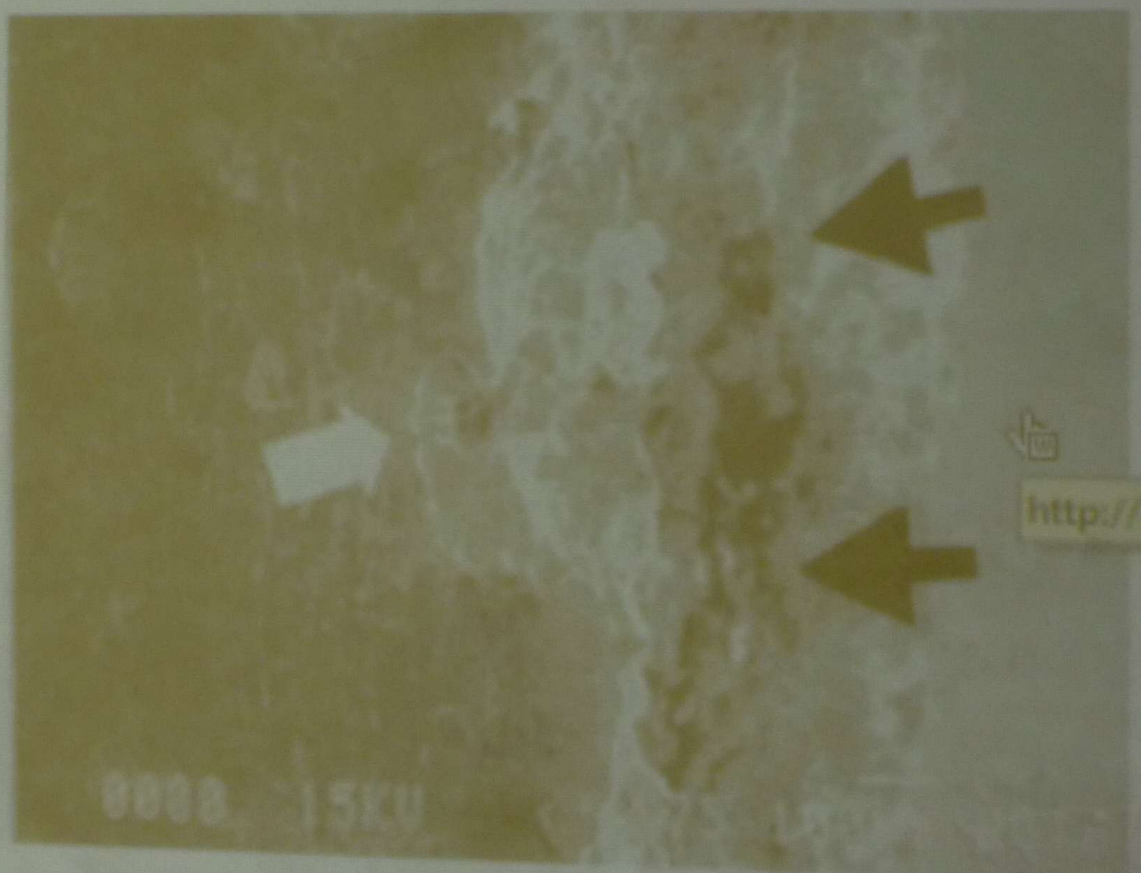
Similar changes in environment occur inside crevices, stress corrosion cracks, and corrosion fatigue cracks. All of these forms of corrosion are sometimes included in the term "occluded cell corrosion."

Pitting corrosion can lead to unexpected catastrophic system failure. The split tubing above left was caused by pitting corrosion of stainless steel. A typical pit on this tubing is shown above right.

Sometimes pitting corrosion can be quite small on the surface and very large below the surface. The figure below left shows this effect, which is common on stainless steels and other film

ls. The pitting shown below right (white arrow) led to the stress corrosion fracture shown by the
arrows.

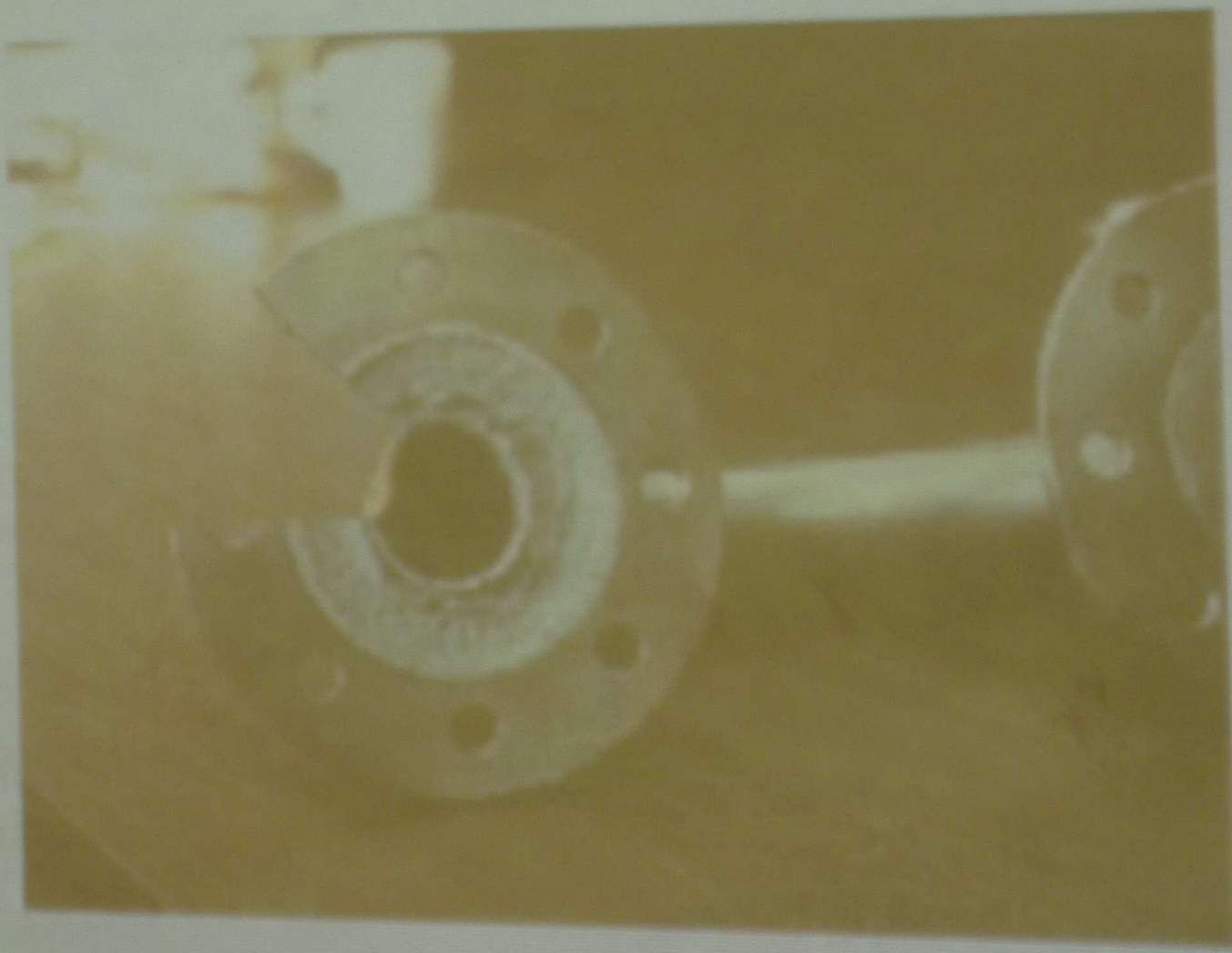




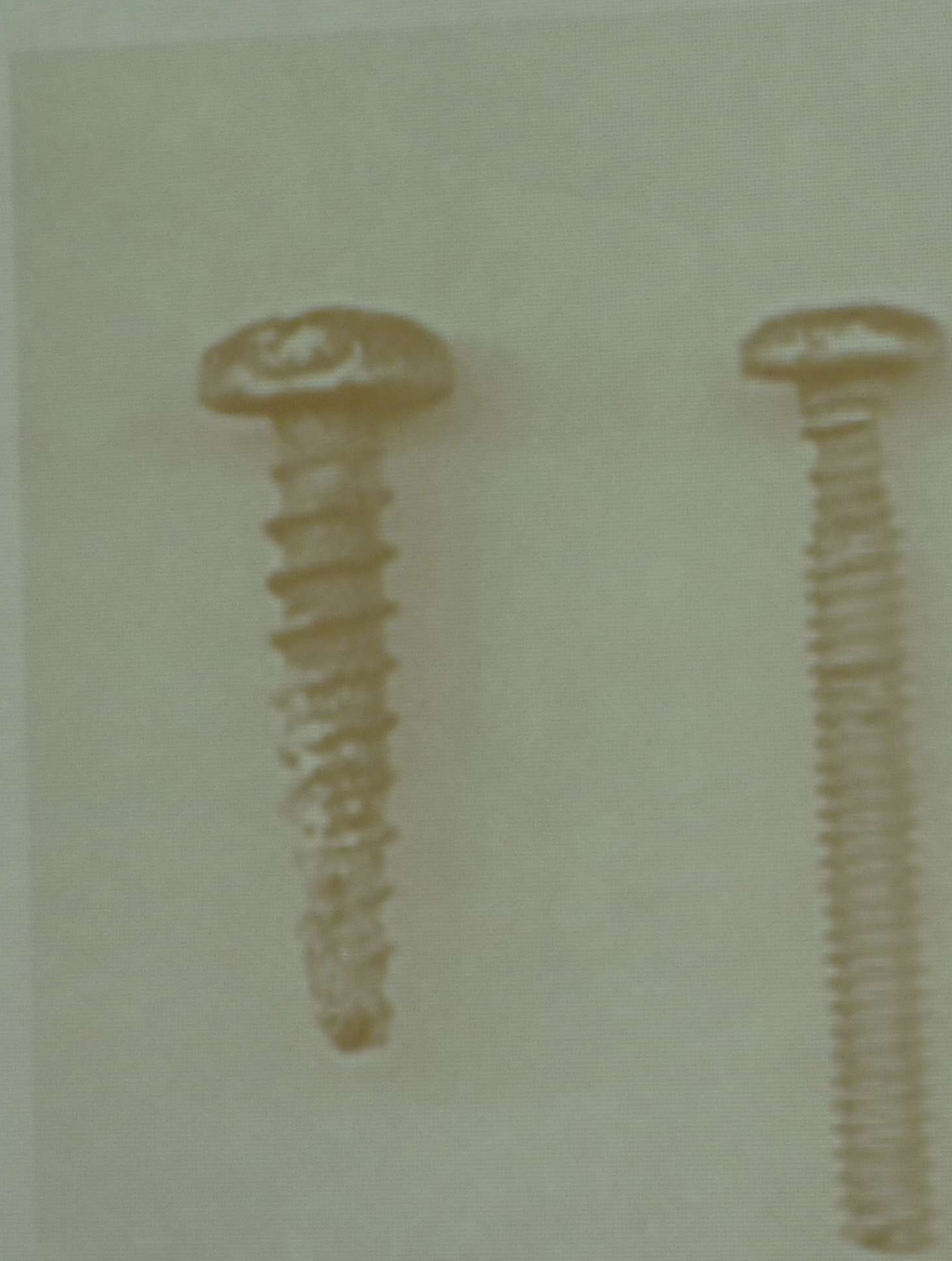
mplete discussion of this corrosion is contained in Steven J. McDanels, "*Failure Analysis Of*
ch Pad Tubing From The Kennedy Space Center," Microstructural Science, Vol. 25, 1998, ASM
ational, Materials Park, OH, pp. 125-129.

contact corrosion is
with nonmetals. It may occur at washers, under barnacles, at
films, and at pockets formed by threaded joints. Whether or not stainless steels are
hey are always susceptible to this kind of corrosion because a nucleus is not nece

s, the proper use of sealants, and protective coatings are effective means of contr
Molybdenum-containing grades of stainless steel (e.g. 316 and 316L) have increas
rrosion resistance.



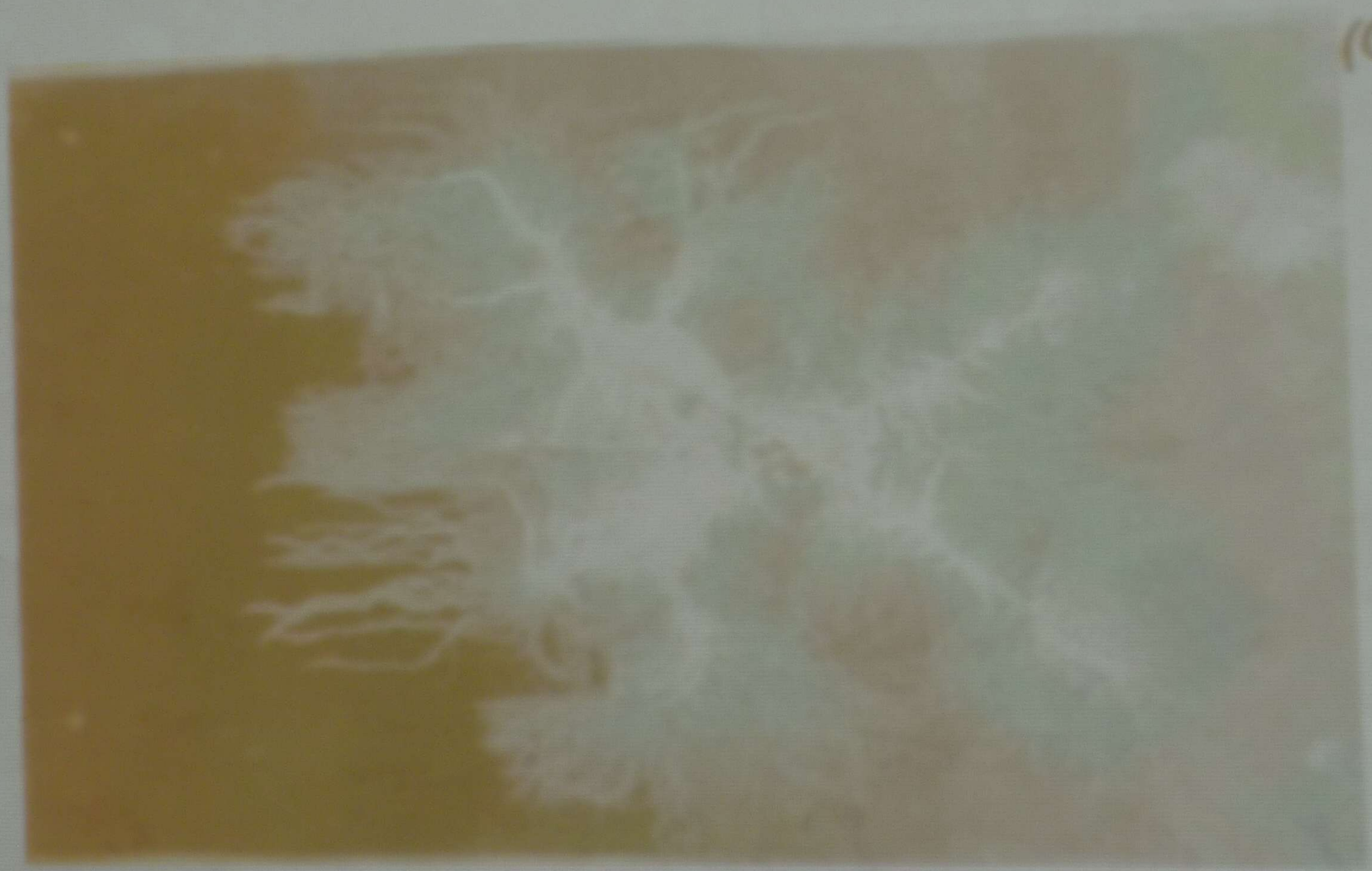
ce corrosion shown above happened when an aerospace alloy (



(Courtesy of marinesurvey.com)

nd "quick-dry" paints are most susceptible to the p
ence of an adverse effect has been proven by field experience. Whe
should exhibit low water vapor transmission characteristics and exc
gs should also be considered for coating carbon steel because of the

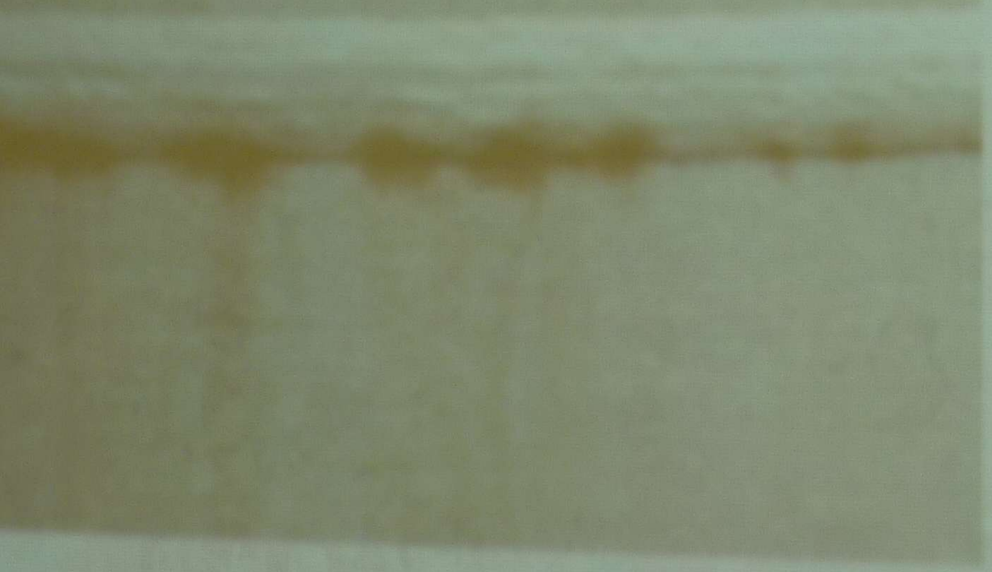
(Courtesy of www.cp.umi



http://v

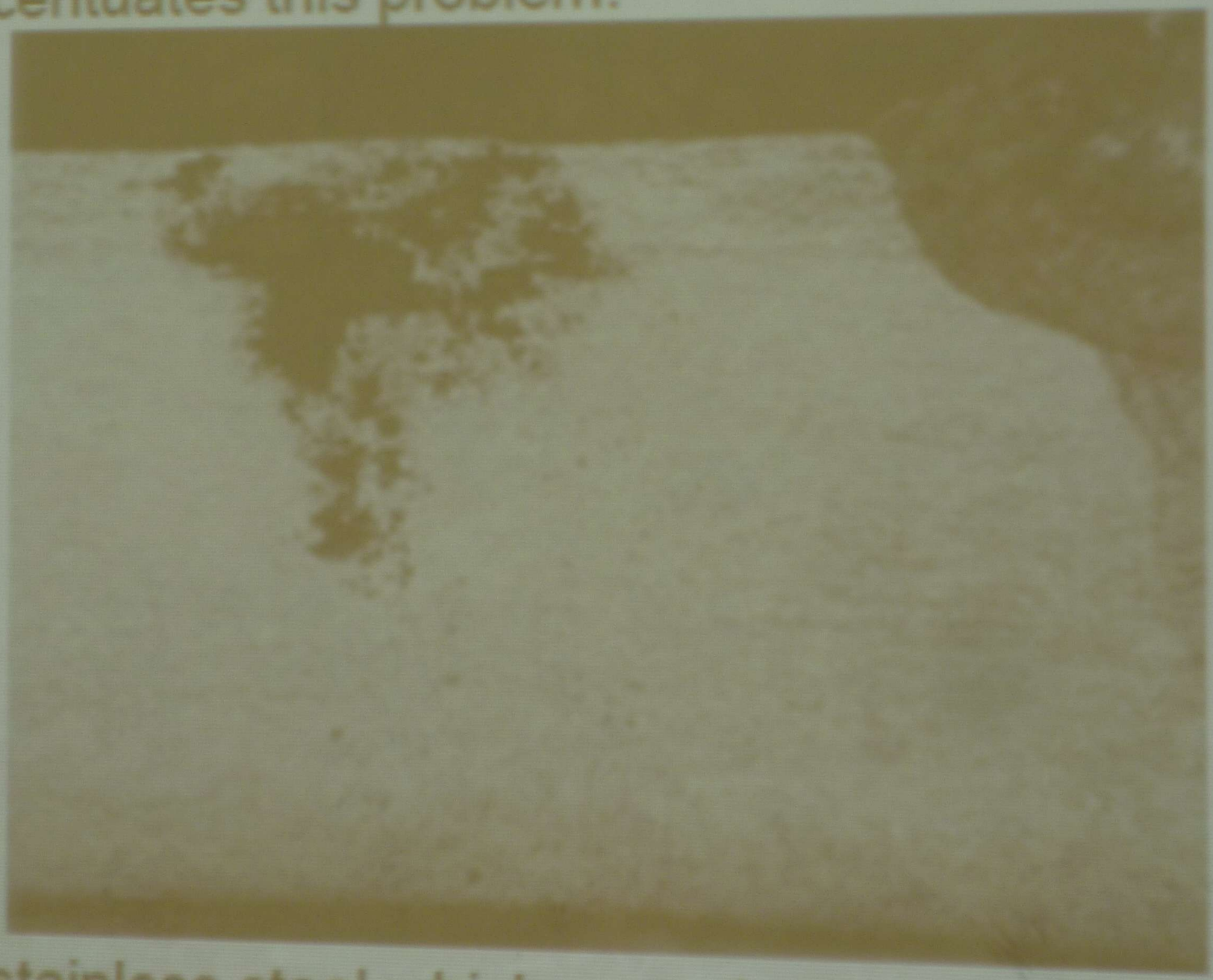
rrosion normally starts at small, sometimes microscopic, defects in

sion normally starts at small, sometimes microscopic, defects in the coating.



n the left shows filiform corrosion causing bleed-through on a welded tank. The p
hows "worm-like" filiform corrosion tunnels forming under a coating at the

s section of most commercial alloys will show its granular structure.
uantities of individual grains, and each of these tiny grains has a cle
ally differs from the metal within the grain center. Heat treatment of
alloys accentuates this problem.



shows a stainless steel which corroded in the heat affected zone a s
d. This is typical of intergranular corrosion in austenitic steels

ed by using stabilized stainless steels (321 or 347) or by using

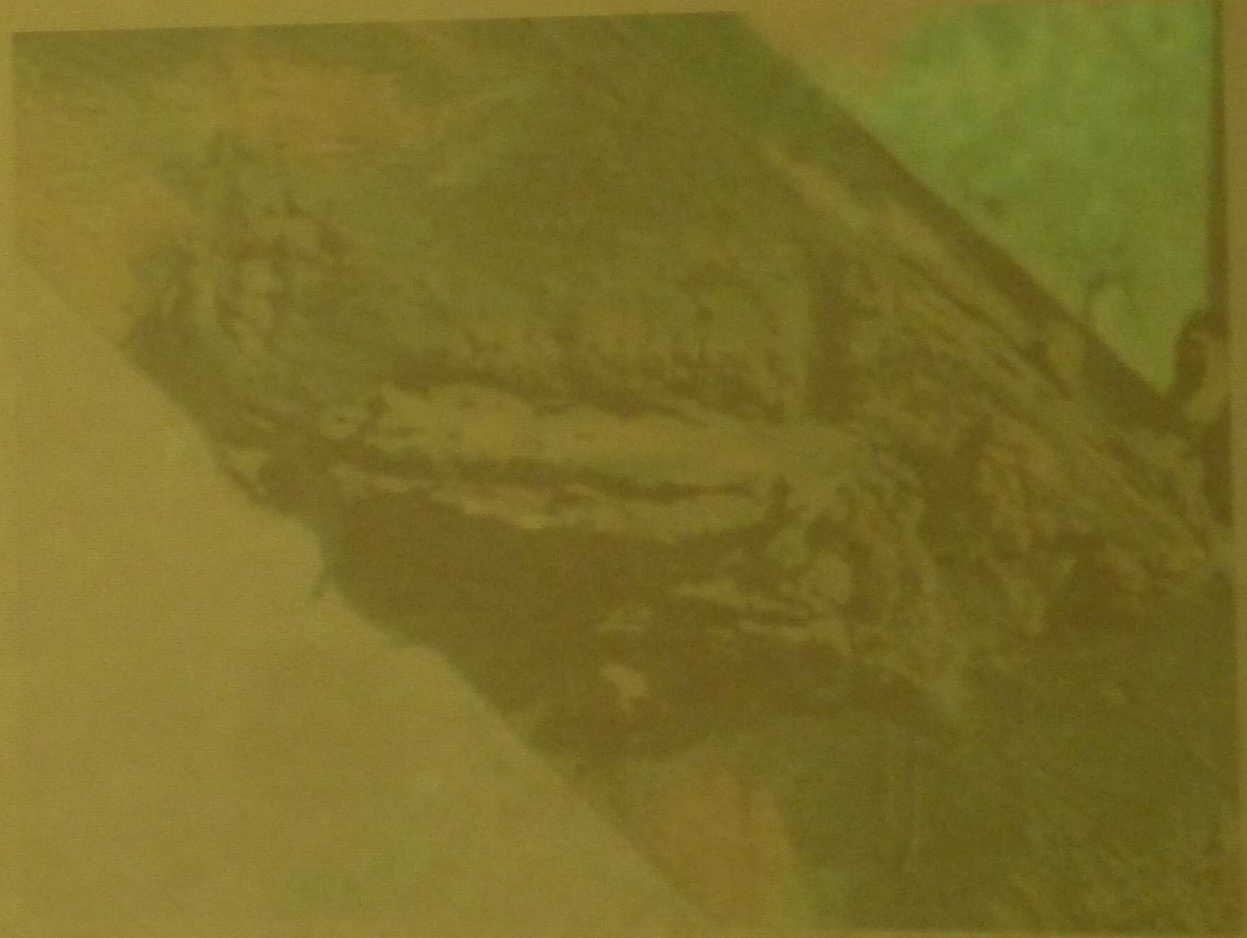
r 316L).

um alloys (2000, 6000, and 7000 series alloys) can also have this pr

ation corrosion below.

n

f intergranular corrosion. It manifests itself by lifting up the surface o



he picture on the left shows exfoliation of aluminum. Exfoliation of carbon steel is apparent in the
nel on the coating exposure panel on the right. The expansion of the metal caused by exfoliatio
osion can create stresses that bend or break connections and lead to structural failure.

Stress Corrosion Cracking

Beach Marks

Corrosion Fatigue of a Propeller

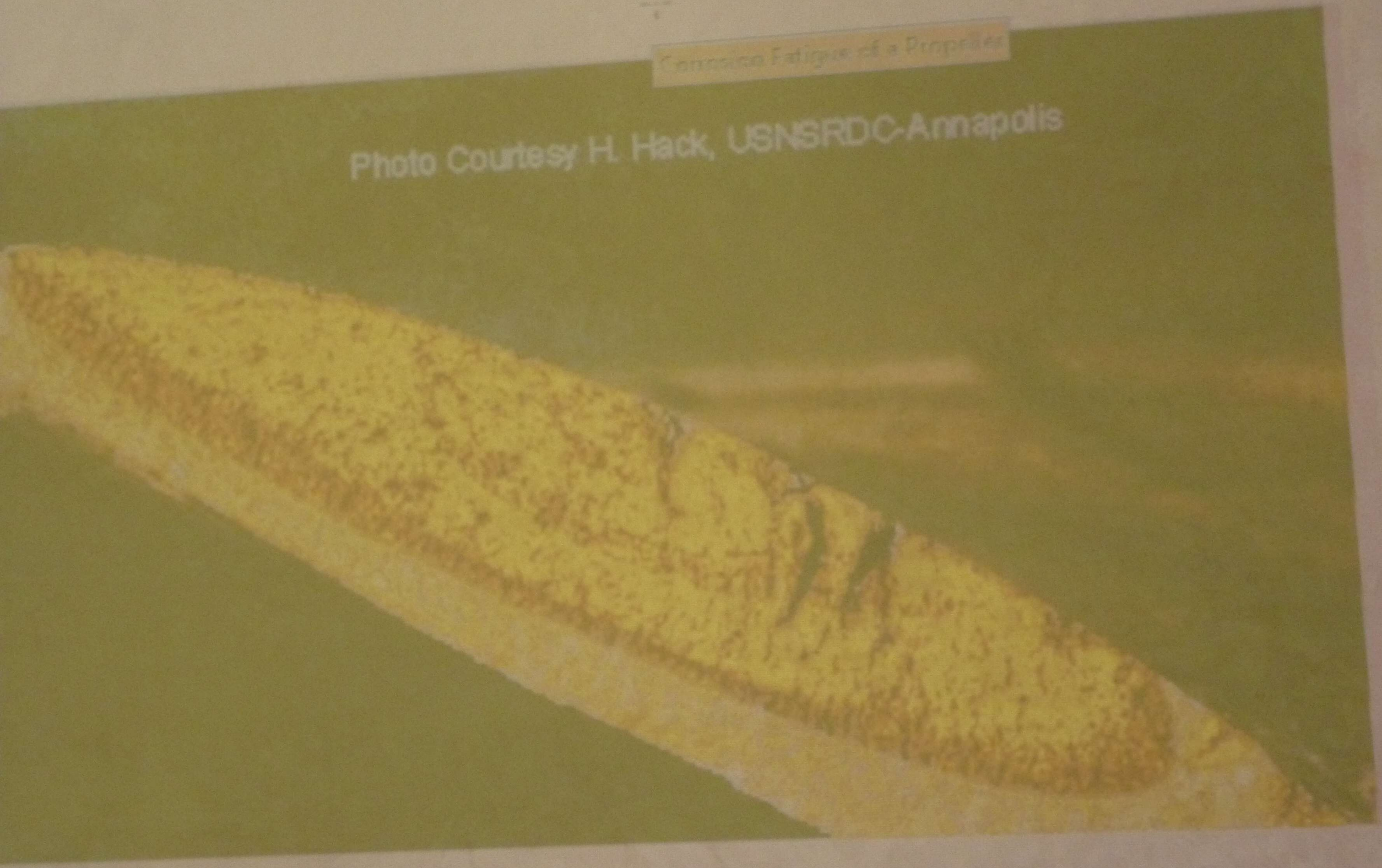


Photo Courtesy H. Hack, USNSRDC-Annapolis

MANUFACTURING PROCESS

NON CONVENTIONAL PROCESS

(a) CHEMICAL MACHINING (CM)

(b) ELECTRO CHEMICAL MACHINING (ECM)

(c) ELECTRO-CHEMICAL GRINDING (ECG)

(d) ELECTRICAL DISCHARGE MACHINING (EDM)

(e) WIRE ELECTRICAL DISCHARGE MACHINING (WEDM)

(f) LASER BEAM MACHINING (LBM)

(g) ELECTRON BEAM MACHINING (EBM)

(h) WATER JET MACHINING. (WJM)

(i) ABRASIVE WATER JET MACHINING (AWJM)

(j) ABRASIVE JET MACHINING (USING AIR (AJM)
SANDS, BEADS)

CHEMICAL M

THIS IS USED
MATERIAL E
ETCHING
BASE ETC.

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(CM)

CHINING (ECM)

GRINDING (ECG)

E MACHINING (EDM)

ISCHARGE MACHINING (WEDM)

TINING (LBM)

TINING (EBM)

LING. (WJM)

- JET MACHINING (AWJM)

MACHINING (USING AIR (AJM)
SANDS, BEADS)

CHEMICAL MACHINING

THIS IS USED FOR REMOVING A LAYEAR of METAL MATERIAL EITHER SHALLOW (OR) DEEP BY MEANS of ETCHING USING CHEMICAL COMPOUNDS LIKE ACID, BASE ETC.

ELECTRO CHEMICAL MACHINING

THIS IS BASED ON DISSOLVING IONS OF THE PROCESSED MATERIALS (METAL) IN THE AREA AROUND THE TOOL WHICH IS THE ELECTRODE (-) OF DC SOURCE AND THE PROCESSED PART IS THE (+) THE IONS THUS BEING REMOVED from THE CONDUCTING ELECTROLYTE.

ELECTRO CHEMICAL GR

COMBINATION OF EL
MACHINING &

ELECTRICAL DISCHARG

THIS IS A WIDELY
METHOD BASED ON
CAUSED BY THE
BETWEEN ELECTRO
PART.

WIRE ELECTRICA

THE ELECTRODE
WHICH IS USED
MATERIAL SIM
USED FOR CO
FLAT (OR) CU

CHEMICAL MACHINING

THIS IS USED FOR REMOUING A LAYEAR of METAL MATERIAL EITHER SHALLOW (OR) DEEP BY MEANS of ETCHING USING CHEMICAL COMPOUNDS LIKE ACID, BASE ETC.

ELECTRO CHEMICAL MACHINING

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ELECTRO CHEMICAL GRINDING

COMBINATION of ELECTRO CHEMICAL MACHINING & CONVENTIONAL GRINDING.

ELECTRICAL DISCHARGE MACHINING

THIS IS A WIDELY APPLIED AND VERY USEful METHOD BASED ON THE EROSION OF METALS CAUSED BY THE DISCHARGE OCCURING BETWEEN ELECTRODE AND THE PROCESSED PART.

WIRE ELECTRICAL DISCHARGE MACHINING

THE ELECTRODE IS A CONTINUOUS WIRE WHICH IS USED TO CUT THE METAL MATERIAL SIMILAR TO HAND SAW USED FOR CONTOUR CUTTING of FLAT (OR) CURVED SURFACES.

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VERY USEFUL
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MACHINING

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ES.

ELECTRICAL DISCHARGE GRINDING

A CONVENTIONAL INTERNAL GRINDING MACHINE IS USED FOR THE GRINDING STONE OF WHICH IS A CONDUCTOR MATERIAL PLAYING THE ROLE OF THE ELECTRODE AND THE PART BEING MACHINED.

LASER BEAM MACHINING

IS USED FOR CUTTING, DRILLING, MARKING, SURFACE MACHINING, WELDING OPERATIONS INVOLVING VARIOUS MATERIALS, METAL, CERAMICS

ELECTRON BEAM PLASMA MACHINING

IS USED FOR VACUUM SURROUNDING MEDIUM

WATER JET MACHINING

USED FOR DYNAMIC CUTTING AND MACHING VARIOUS MATERIALS : PLASTIC, RUBBER, FOOD STUFFS, PAPER, LEATHER, INSULATION MATERIALS.

QUALITY COMPARISON

- SURFACE ROUGHNESS.
- DIMENSIONAL TOLERANCE
- STRUCTURE OF THE MATERIAL IN THE CUTTING AREA
- PROCESS EFFICIENCY
- TOOL WEAR
- ENVIRONMENTAL CONSIDERATION.
- PERSONNEL SKILLS.