1) a) Driving force for both recovery and recrystallization is the difference in internal energy between the strained and unstrained material.

Driving force for grain growth is energy associated with grain boundaries. As grains increase in size, the total boundary area decreases, yielding an attendant reduction in total energy.

b) Difference between recovery and Recrystallization

In recovery, some of the internal energy is relieved by virtue of dislocation motion where as, in recrystallization a new set of strainfree and equiaxed grains are formed.

Recrystallization have lower internal energy than recovered material.

c)

Hot working	Cold working
→ Temperature higher than recrystallization temp.	→ Working temperature lower than recrystallization temp.
→ Lower hardness	→ Generally higher than that of hot working
→ High errors attending shrikage	→ low errors of shrinkage
→ Metal remains soft & ductile	→ Metal becomes brittle due to strain hardening
→ Low workability	→ High workability of metal
→ Poor surface finish	→ Better surface finish

d) Recrystallization's driving force is strained internal energy. When material undergoes high degree of ~~st~~ cold work, due to ~~ha~~ high strained energies because of high strain hardening recrystallization is much more favoured.

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2) a) Strength and toughness of a polycrystalline material single phase cane be increased by Grain Boundary Strengthning mechanism

b) Equations governing

i) Grain boundary strengthening

$\sigma_{yield} = \sigma_0 + k_y d^{-1/2}$ - Hall pitch Equation

ii) Solid solution strengthening

$\sigma_y \sim c^{1/2}$

iii) Strain Hardening

% Cold work $CW = \frac{A_0 - A_d}{A_0} \times 100$

iv) Precipitation hardening

$\tau_y = Gb/L$

c) If a polycrystalline material have random distributed orientations, these are called crystallographic texture. Twining is a method of producing crystallographic texture

d) i) Polycrystal: As the slip of a grain in polycrystal depend on boundaries it share with other grains, it generally can endure higher stresses

ii) An Alloy is stronger than a metal as impurities put themselves at points of dislocations and increase strength of material.

iv) Coarser the distribution of incoherent precipitates, is more difficult for dislocations to force through and thus, stronger they are

iii)

v)

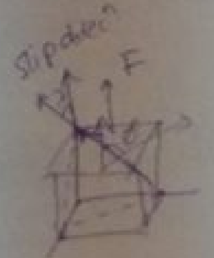
3) 

τ_R
Resolved

4 a) One of
Its compo
in gas -
Processin
temperat

b) Ti allo
implant,
rims,
Guide

v)

3) 

given slip direcⁿ = [$\bar{1}$01]
stress direction = [001]
Slip plane = (111)

$$\cos\phi = \frac{1}{\sqrt{0^2+0^2+1^2}\cdot\sqrt{1^2+1^2+1^2}} = \frac{1}{\sqrt{3}}$$

$$\cos\lambda = \frac{1}{\sqrt{2}}$$

$\tau_R = \sigma \cos\phi \cos\lambda \Rightarrow \tau_R = \left(1.1 \times \frac{1}{\sqrt{2}} \times \frac{1}{\sqrt{3}}\right)$ MPa

Resolved shear stress

$$\boxed{\tau_R = 0.45 \text{ MPa}}$$

4.
a) One of the common Ti alloys is α-Titanium alloys. Its composition by wt% is 5 Al and 2.5 Sn. It is used in gas turbine engine casing and rings; chemical processing equipment ~~requirin~~ requiring strength to temperatures of 480°C (900°F)

b) Ti alloys are used in surgical equipment, 3-D chest implant, machine parts, propellers, engines, wheel rims, automobile engines, chasis of automobiles, Guide wires

5) a) IC fabrication techniques

i) Diffusion and ion implantation (iv) Lithography

ii) Oxidation and film deposition (v) Etching

iii) Epitaxial growth (vi) Photoresist (vii) Deposition

b) Examples of some of semi-conductor materials

C, Si, Ge - (Elemental)

GaAs, GaN, InP, AlSb, GaAlAs, GaInN, ZnSe, CdTe - Compounds

c) Carbon Nanotubes

-> Two of its dimensions are of nano scale.

-> Fullerene structural family with cylindrical nano structures

-> Nano tubes are hollow nano rods

-> These comprise SP_2 bonds like that in graphite

Applications

-> These are used in nanothechnology, electronics, optics, carparts, golf clubs, optial imaging, ultra sound imaging, automobile parts