- **Metal Finishing -**

Contents :-

- Theory of electroplating.
- Polarization, decomposition potential & overvoltage
- Characteristics of a good deposit.
- Factors influencing the nature of deposit.
- Methods of cleaning the metal surface
- Hard chromium & decorative chromium plating
- Electro-less plating - Copper plating.

METAL FINISHING

Process of deposition of an adherent metallic film of a noble metal on a base metal or polymer surface.

→ **Objectives:-**

- In general a metal ~~a~~ or alloy used for a purpose does not meet all requirements. Metal finishing is one of the method employed to improve their lacking properties.

- Improving resistance to corrosion, chemical.

Metal Finishing

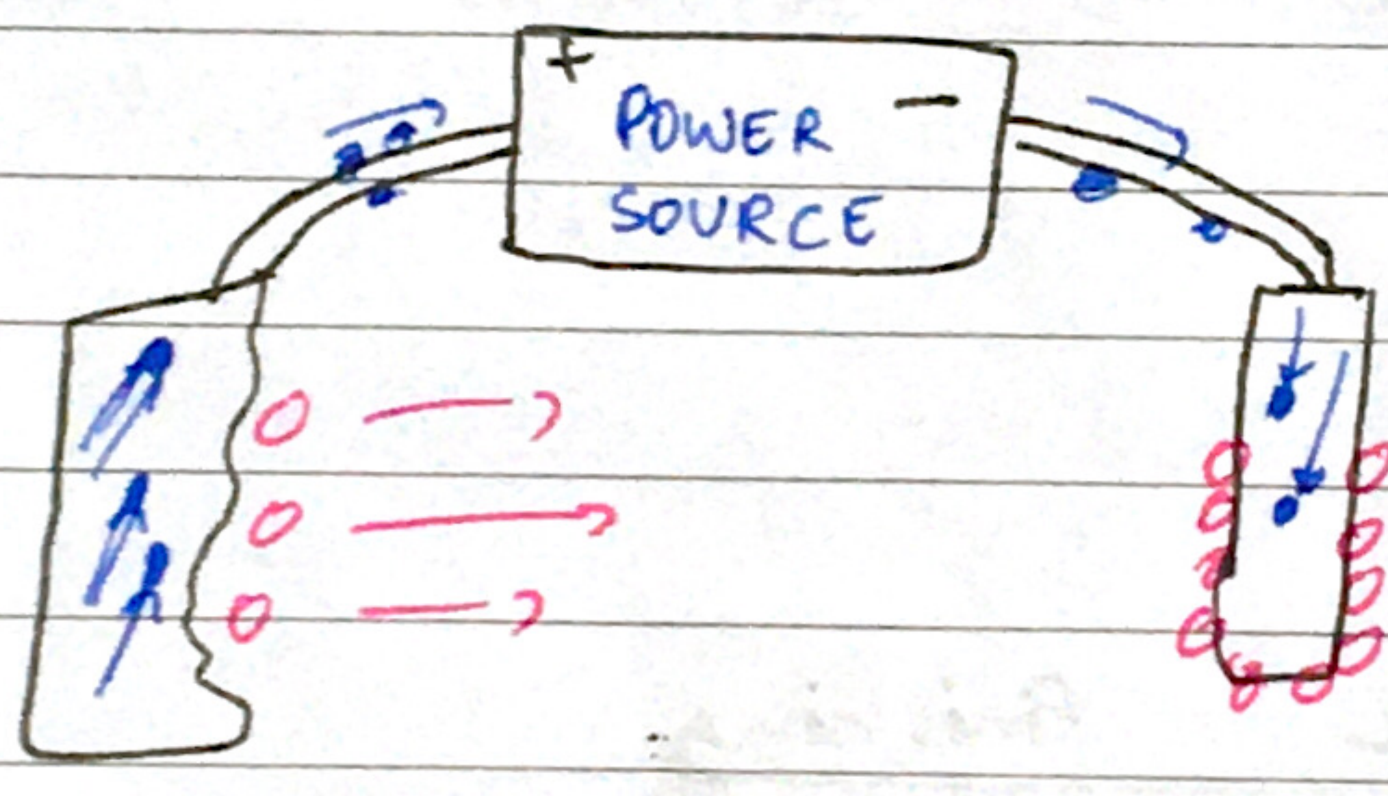
→ Electroplating
  - ↓ using electricity
  - Electroplating from chromium

→ Electrolessplating
  - ↓ using reducing agents
  - Electroless plating of copper.

- Electroplating :- Process in which a thin layer of ~~sat~~ coating metal is deposited on a base metal by passing dc. through an electrolytic soln. containing the soluble salt of the coating metal.

- Theory of electroplating :- Anode, cathode, Electrolyte, Direct curr

Essential Components :-



A d.c electrical power source.

Anode :- Inert material / coating metal

*In this case the electrolyte will be the actual source for the transfer of e^-.

Cathode :- Article to be plated.

Electrolytic bath :- Soln of conducting salt, metal to be plated in a soluble form buffer. and additives.

Container :- Made up of rubber lined ~~steel~~ steel wood or concrete.

Electroplating of Copper :-

Anode :- Made of ~~ed~~ coating metal

Cathode :- Article to be plating

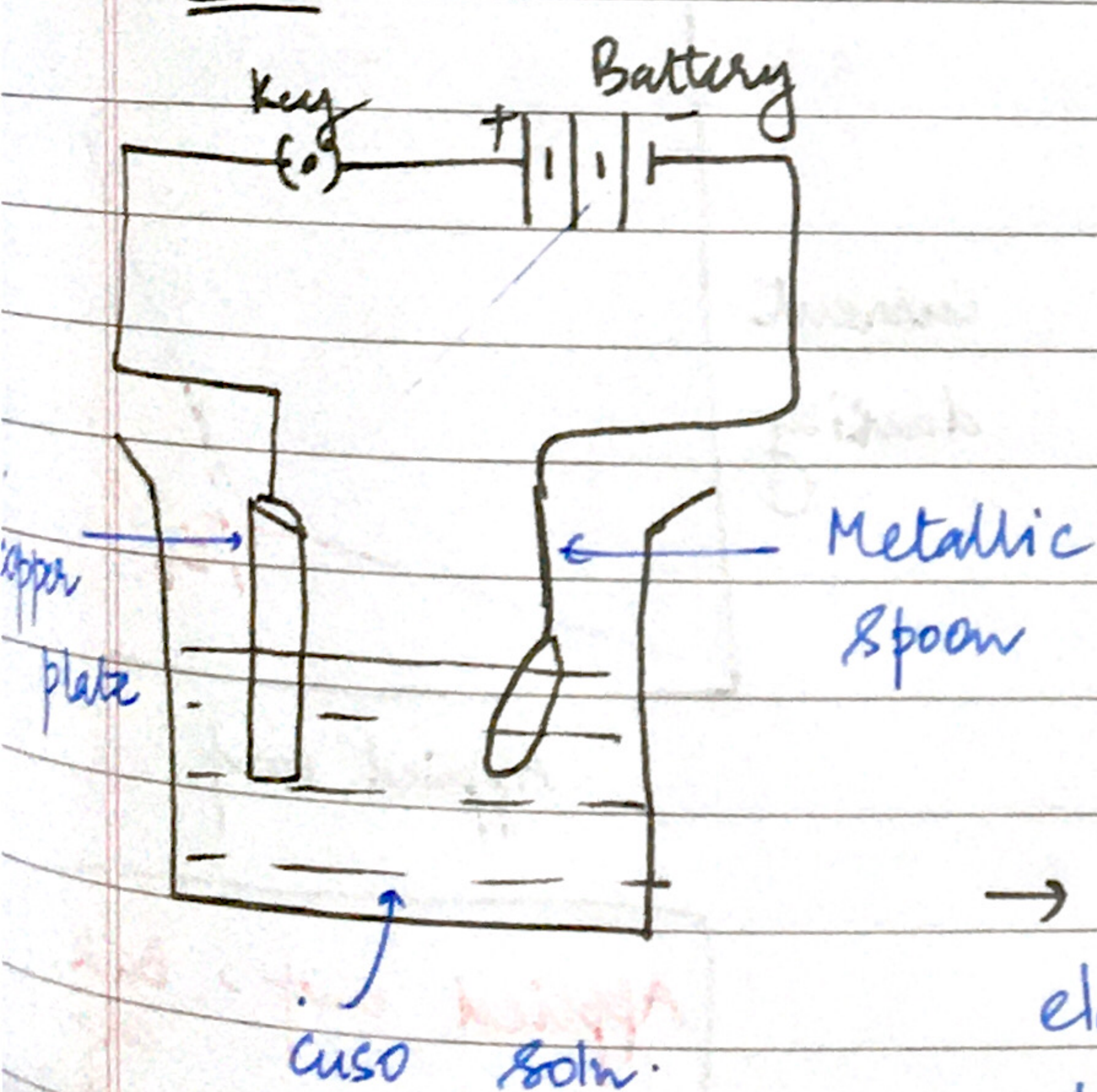
Electrolyte :- $CuSO_4$ soln.

$$CuSO_4 \rightarrow Cu^{2+} + SO_4^{2-}$$

→ **On passing current**

Cathode :- $Cu^{2+} + 2e^- \rightarrow Cu$ (cathode)

Anode :- $Cu + SO_4^{2-} \rightarrow CuSO_4 + 2e^-$



→ Continuous replenishment of electrolytic salt during electrolysis. If anode is some inert material like graphite, then electrolytic salt is added continuously to maintain proper coating metal ion concentration.

- **Factor Governing Electroplating**

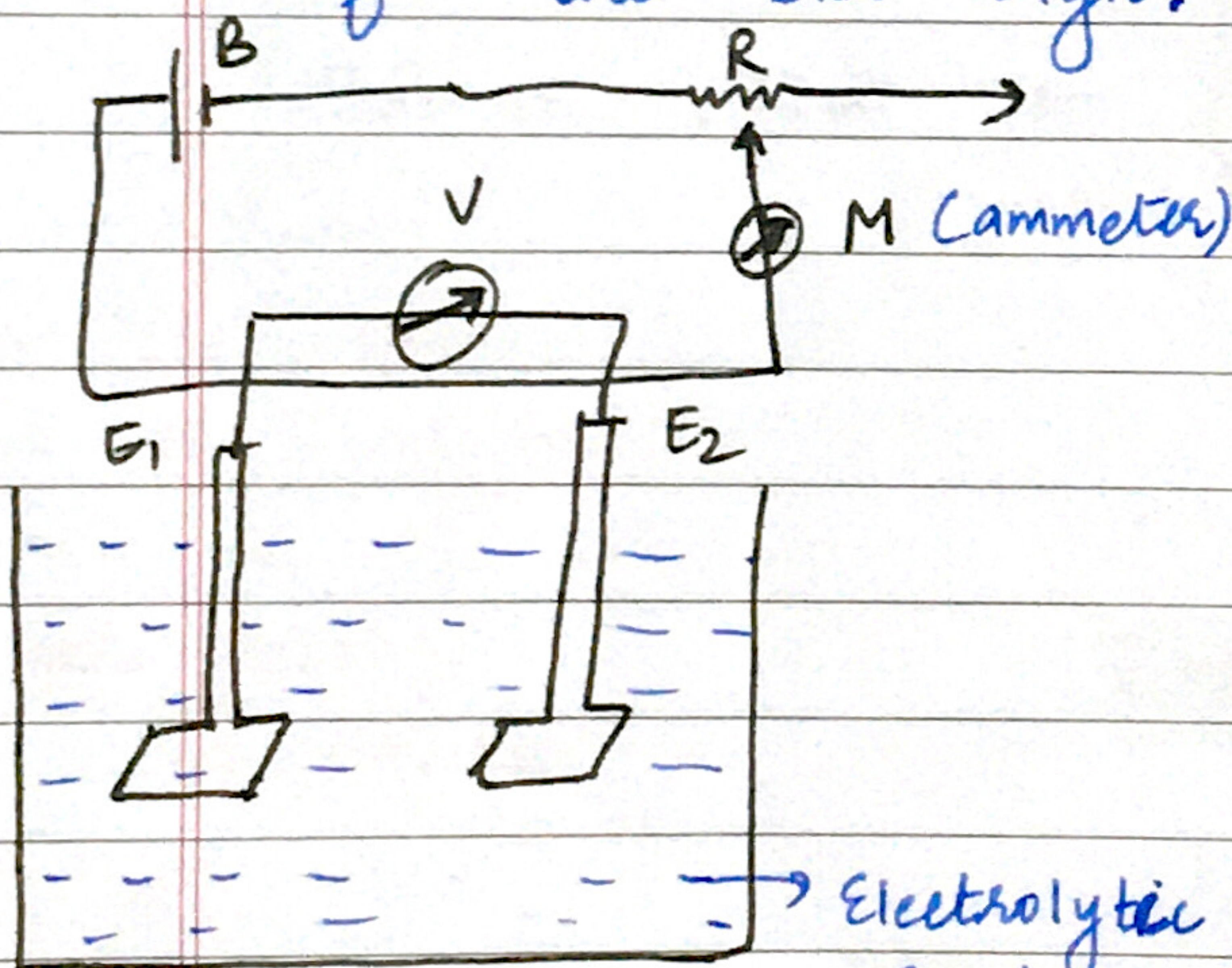
→ Decomposition Potential (D.P.)

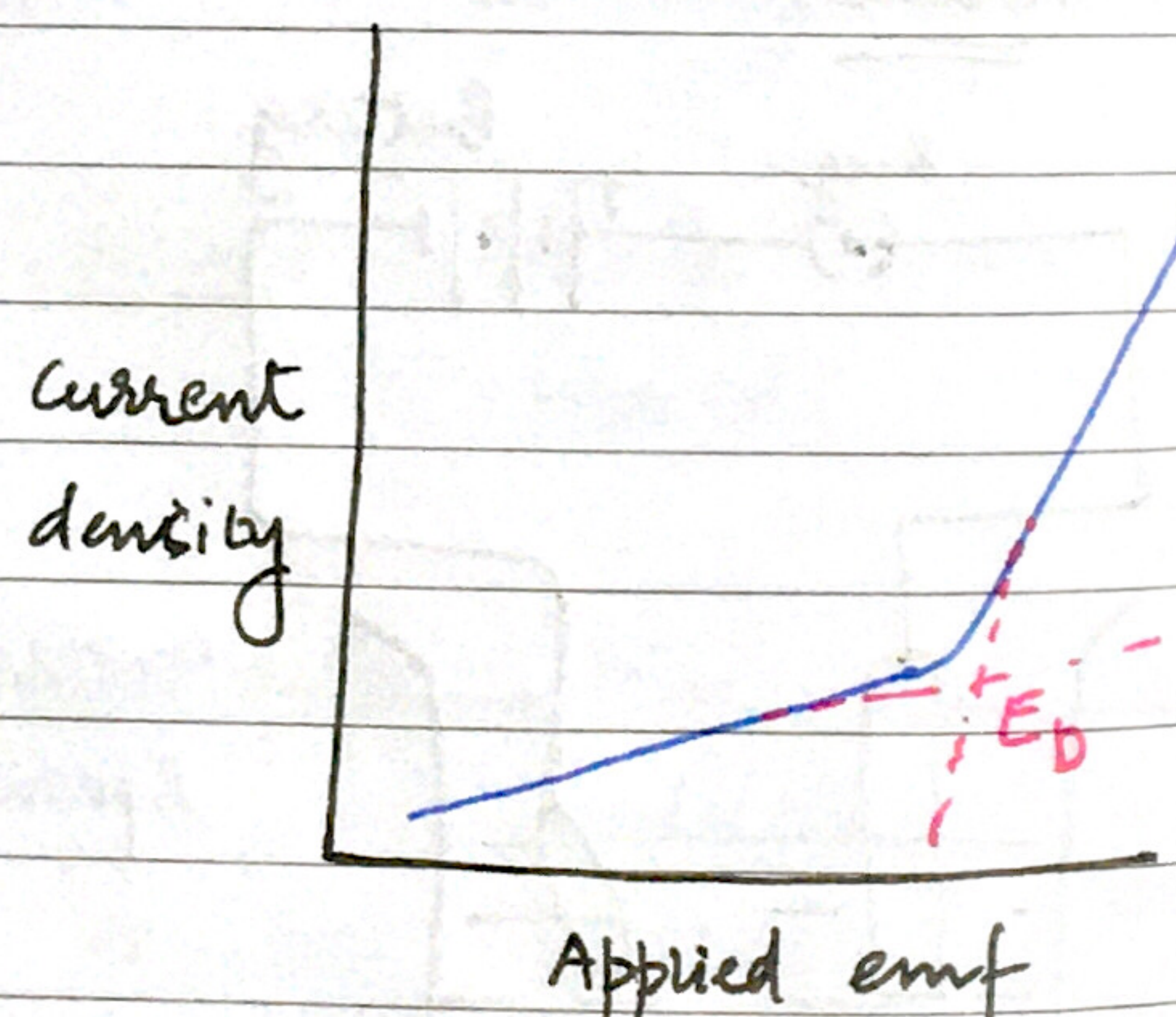
→ Polarization

→ Overvoltage.

→ **Decomposition Potential**

→ Minimum external potential at which the electrolysis current begins to increase appreciably & continuous electrolysis sets in is known as decomposition potential of the electrolyte.





- R: Rheostat.
- E_1 & E_2 : Pt. electrode.

Applied emf > Back emf

→ only then we see smooth & continuous electrolysis to occur. (1.7 V and beyond)

→ & this applied voltage (emf) is seen as E_D in graph.

→ E_D :- Decomposition Potential.

1.7

can change depending on temp., environment etc.

→ The applied emf is increased with the help of ~~ammeter~~ ~~changeable~~ ~~resistance.~~ ~~[illegible]~~ ~~[illegible]~~ variable resistor.

- **Factors affecting Decomposition Potential**

1. Strength of the current flowing through the cell.

2. chemical nature of the electrodes.

3. Physical nature of the electrodes.

4. Activity of the electrolyte.

5. Absolute temperature.

6. Uses of D.P.

→ Difference b/w actual applied emf — the theoritical value.

- **Overvoltage:-** • The decomposition of an electrolyte is expected to start as soon as applied potential reaches the value of reversible emf of the cell.

- But when products discharged at the electrode are gases, then the actual decomposition potential is invariable much higher than its theoretical reversible electrode potential.

The excess voltage is referred to as over voltage of the gas.

- Difference b/w the actual applied emf to bring about continuous ~~elet~~ electrolysis & the theorectical emf needed for such electrolysis.

- **Factors affecting overvoltage:-**

1. Nature & physical state of the electrolysis.
2. Current density
3. Temperature
4. Nature of the electrolysis
5. Nature of the material deposited.

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• **Polarization :-**

① Development of over potential in an electrolysis cell is called polarization.

② ~~...~~ Electrolytic process occur at the electrodes of the cell.

③ Polarization sets in the cell when the electrode process become slow and irreversible.

④ Magnitude of over potential (voltage) is directly proportional to the ~~...~~ extent of polarization

→ **Types of Polarization**

• Concentration polarization

• Kinetic or activation polarization.

Concentration Polarization

- An electrochemical rxn occurs only at the surface of the two electrodes.

- Adjacent to the electrode surface reactant concentration decreases.

- The reactant species transported to the electrode surface by processes like diffusion and migration from bulk of the solution

- Current flowing through the cell drops when rate of transport is insufficient to match the electrode rxn.

- A potential higher than the theoretical value is required to maintain the current at the necessary level.

- can be minimized by :-

  1. By raising the temperature
  2. Mechanical agitation of the solution.

In short
→ 5 steps take place:- (Activation Potential)

1. Diffusion of reactants to electrode
2. Adsorption of reactant onto the electrode.
3. Charge transfer
4. ~~Det~~ Desorption
5. Diffusion of product away from electrode

→ Activation Polarization :-

• This is ~~caus~~ caused when any of the following steps become slow and need activation energy

• Adsorption of the reactant on the electrode.

• charge transfer ~~acco~~ across the metal - solution interface.

• ~~Depos~~ Desorption of the product from the electrode.

• A higher potential than the theoretical value is to be applied to maintain current at the necessary level.

→ Characteristics of a good deposit

• The deposit should be bright and lustrous

• The deposit should be continuous, uniform, non porous and adhesive.

• It should be hard and ~~d~~ ductile.

• It should be fine grained nature.

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- **Factors Influencing The Nature of Deposit:**

① **Current Density:-**

An optimum current density should be applied.

→ If low → leads to slow process, take more time to complete the process.
→ Results in coarse grained deposit.

→ If high:- → more deposition, but poor adhesion
→ leads to rough and brittle deposit.
→ result in burnt and spongy deposit.

② **Metal salt and electrolyte concentration**

- Moderate / low electrolyte concentration should be maintained in bath to get a better deposit.

- If concentration of metal ion is low the crystal size will be smaller and a fine adherant film may be coated.

- ~~[illegible]~~ Firm and adherant deposits.

→ Low metal concentration can be acheived:-
- By addition of a compound with a common i
- By formation of complex compounds.

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- Temperature :-

(1) It should be b/w 35°c – 65°c

(2) Lower temp. :- → reduces the solubility of the metal salt.

→ reduces the mobility of the ions.

(3) Higher temp. :- → increased metal dissociation, higher ionic mobility & conductance.

(4) crystal size increases, poor adhuence. affects the lining of the equipment, electrode surface and the substrate. Decomposition of organic agents and H_2 evolution.

Agitation :-

- Agitation of the soln. brings up a fresh supply of metal salts to the cathode.

- It also sweeps away gas bubbles which may otherwise cause pits.

- Rapid agitation may :-
  - → stir up the sludge
  - → results in rough and porous deposits.

pH of the electrolytic bath

- Suitable pH is maintained using appropriate buffers.

- In Ni plating borate is used to maintain pH 4.5.

- At low pH more H_2 evolution takes place at cathode & burnt deposit.

- At higher pH precipitation of hydroxides of metal takes place.

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- **Addition agents:-**

• The wide range of additives are added in low concentrations, serve to electroplating bath to modify the structure and properties of the electrodeposits.

- **Function:-**

Makes the deposit smooth, fine grained, hard and ~~adher~~ adherent.

- **Types of additives:-**

① **Complexing agent:-**

Eg. Cyanide, sulphamite ions

② ~~Brighteness~~ **Brighteners:-**

Eg:- Aromatic sulphonates, thiourea.

③ **Wetting Agents:-**

Eg. Sodium lauryl sulphate

④ **Levelers:-**

Eg. Cellulose derivate

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- Throwing powder :-

1. Throwing power is defined as the degree of uniformity of metal distribution or evenness of deposit thickness obtained on a cathode of irregular shape

2. If the distribution of the deposit is uniform throughout the surface of the article to be coated, the throwing power is considered good.

3. Tendency of planting bath solution to give uniform coating irrespective of the shape of the object.