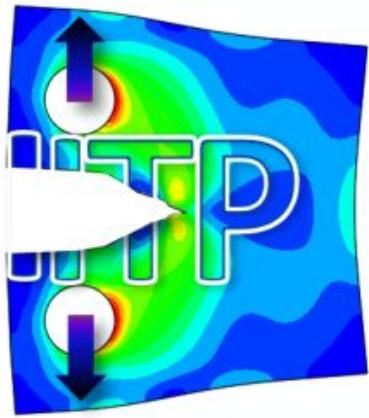


ME150: Manufacturing



Dr. Pankaj Kumar

Department of Mechanical Engineering
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Joining
Process

Welding



Brazing
Soldering
Adhesive bonding

Mechanical
Assembly
(Threaded
joints
Fasteners
Rivets)

Fusion Welding

Energy Ray

Electron Beam Welding

Laser Beam Welding

Low Temperature Sources

Braze Welding

Brazing

Soldering

Electric Arc

Metal Arc Welding

Carbon Arc Welding

TIG Welding

MIG Welding

Submerged Arc Welding

Electro Slag Welding

Chemical Energy

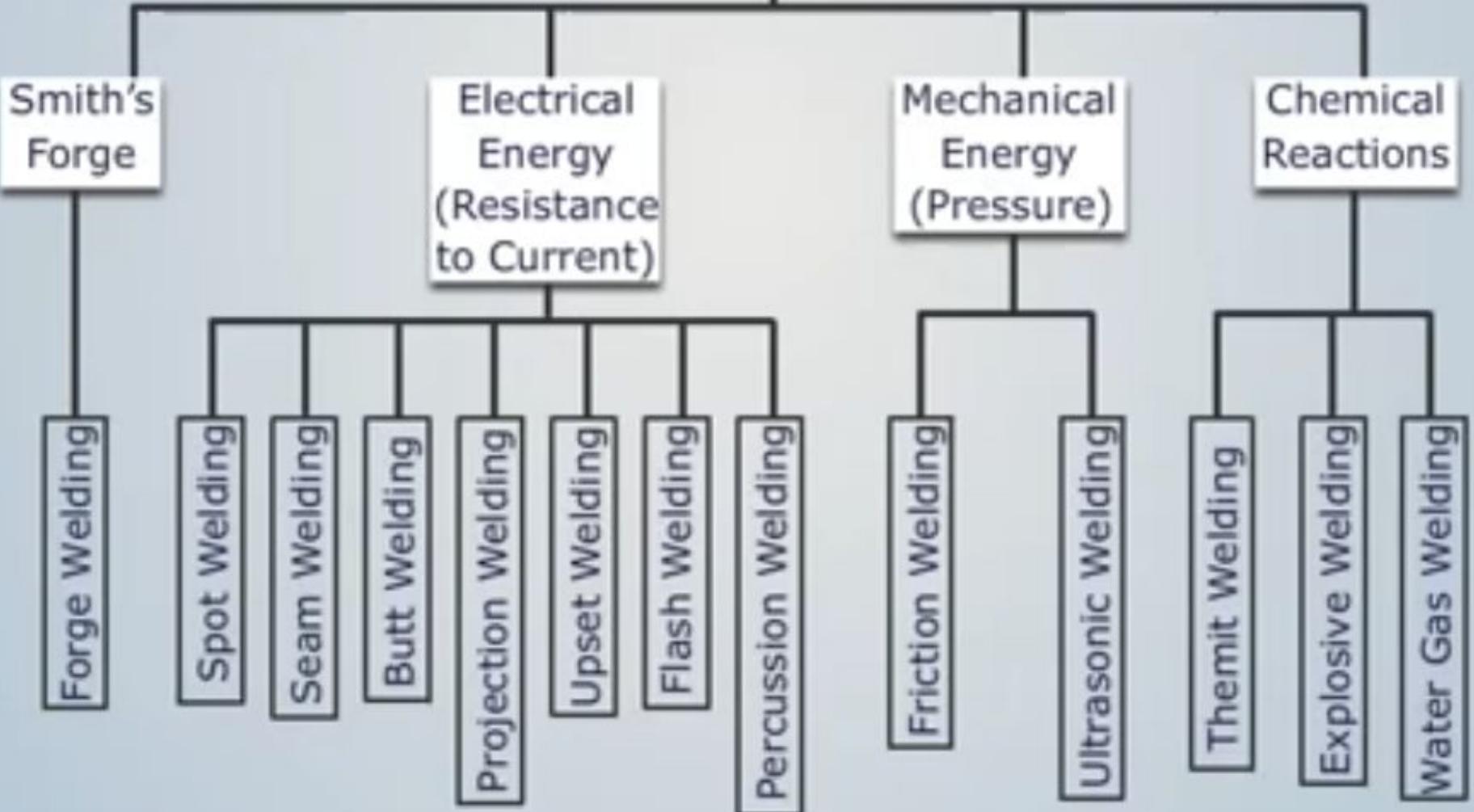
Atomic Hydrogen Welding

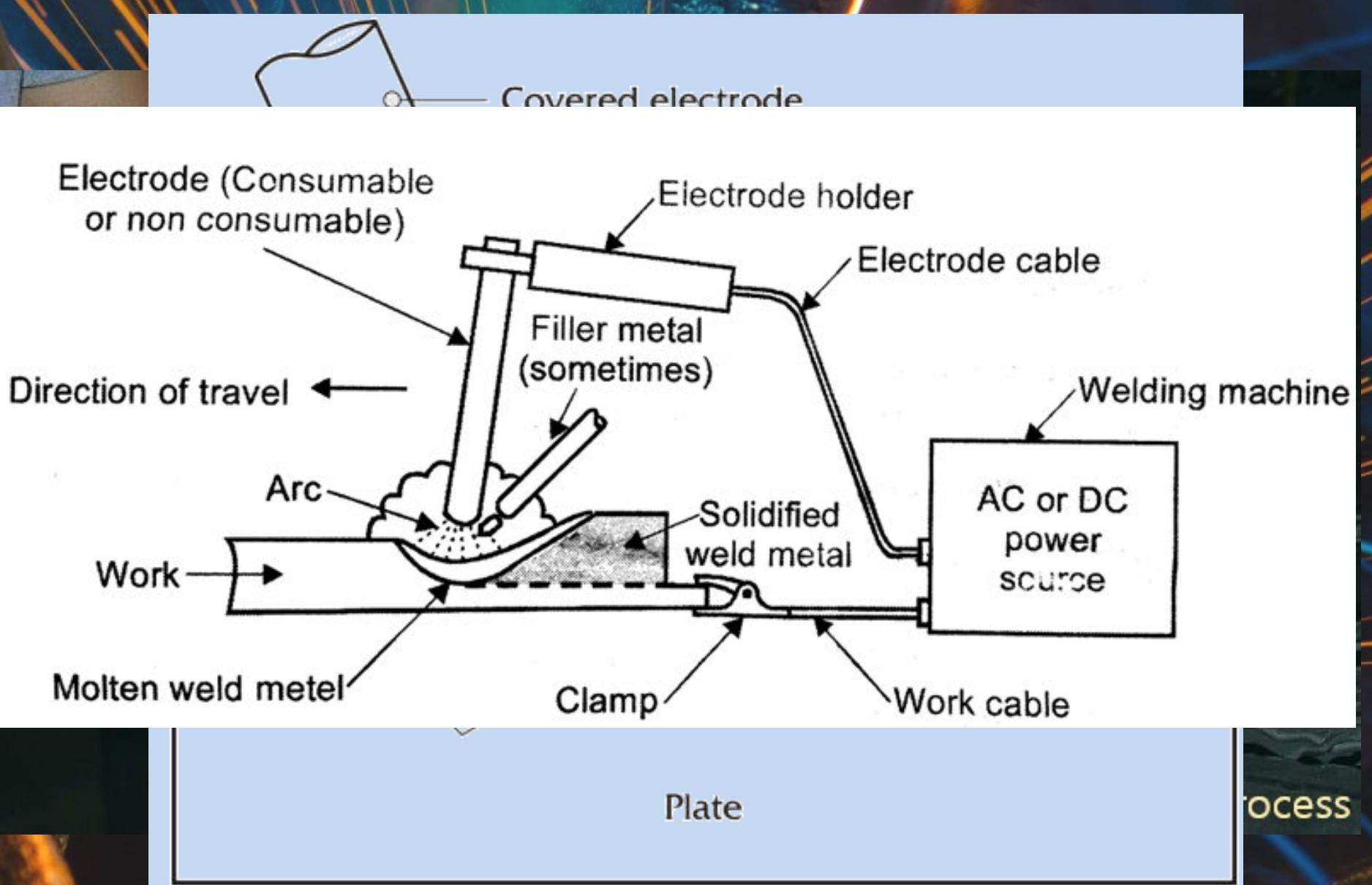
Gas Flame Welding

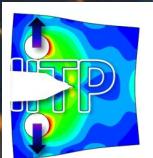
Oxy-Hydrogen Welding

Oxy-Acetylene Welding

Pressure Welding





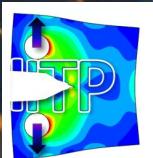


DC Polarity Output

Why not preferred???

- **Losing of arc** Because the current fluctuates back and forth, the arc needs to restart itself at every turn of the current between positive and negative. Sometimes, the arc cannot restart itself, and you must manually restart it.
- **Spattering** Spatter is the tiny bits of metal debris often found surrounding AC welds. This is a result of the fluctuating current as well.

TIME (seconds)

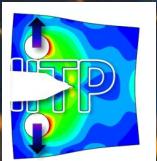


Three different polarities used in arc welding

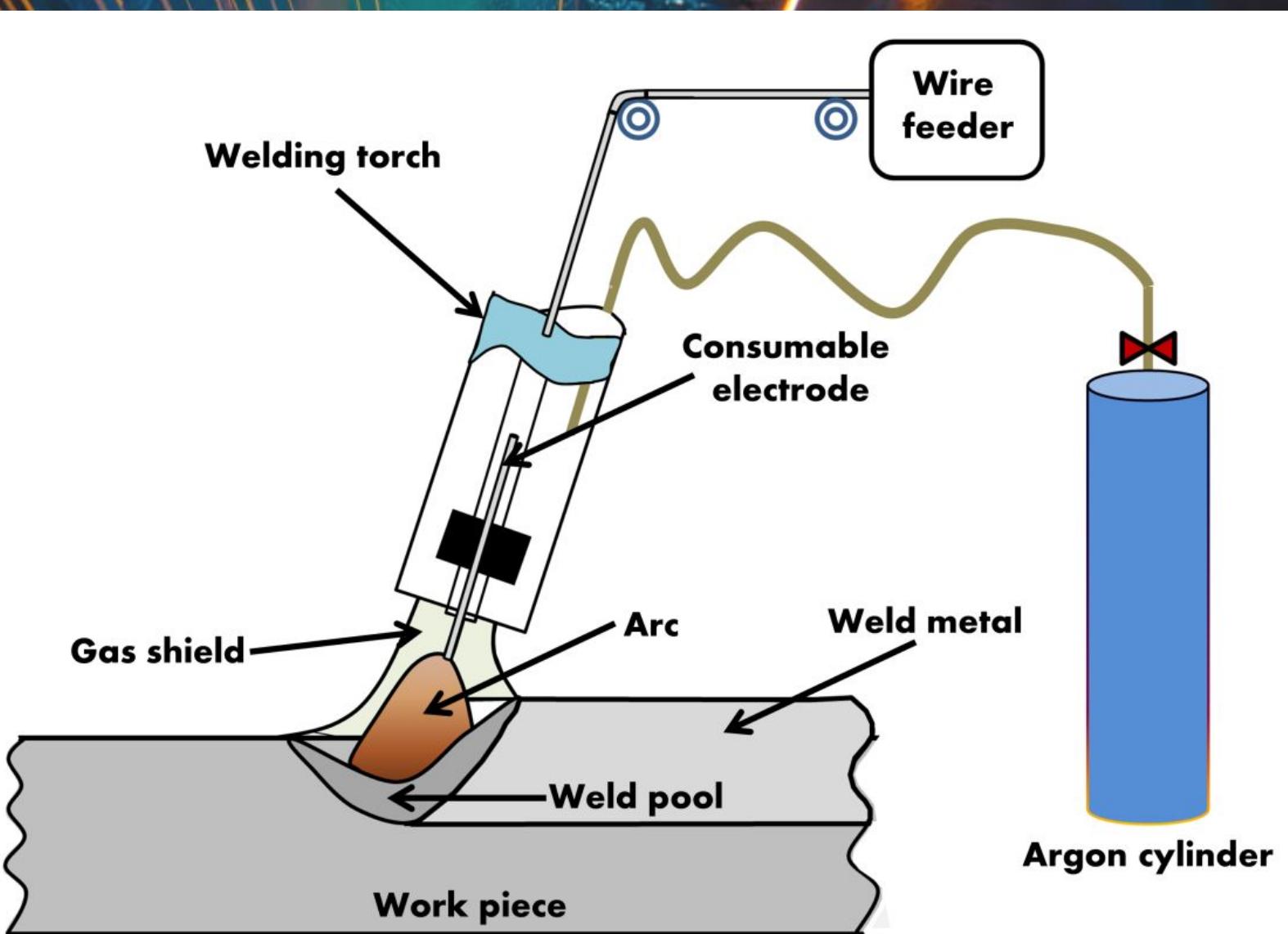
Direct Current Electrode Positive (DCEP) polarity

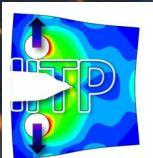
With direct current (DC) power supply, when electrode is connected with positive terminal and base plates with the negative terminal, then it is termed as Direct Current Electrode Positive (DCEP) or Direct Current Reverse Polarity (DCRP). So electrons liberate from base plate and flow towards electrode via the outer circuit. Continuous flow of avalanche of electrons in a small passage produces the arc (source of heat).

second.



Difference between TIG and MIG welding



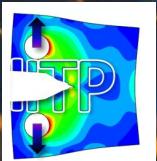


Fusion welding: Tungsten inert gas welding

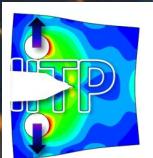


Advantages of TIG welding

- Non-consumable electrodes: It helps in flawless joints
- No flux is required because inert gas shields molten metal. So no slag and slag inclusion problems
- High quality and strong welding achieved by TIG
- Suitable for welding of very thin sections
- Nonferrous metals like aluminium, copper and dissimilar metal can be welded without any challenge
- Non-corrosive and ductile joints
- Less distortion due to small heat zone.



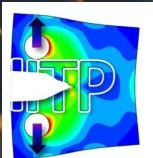
Shielding Gas



Types of Shielding gases



- Shielding gas forms a protective atmosphere over the molten weld pool to prevent contamination
- *Inert* shielding gases, argon or helium, keep out oxygen, nitrogen, and other gases
- *Active* gases, such as oxygen and carbon dioxide, are sometimes added to improve variables such as arc stability and spatter reduction



Types of Shielding gases



Shielding Gas Recommendations

BASE MATERIAL

COMMON

SPECIALIZED

ALUMINUM

100% Ar

98/2 Ar/He
(weld penetration >
¼" base material)

MILD STEEL

100% CO₂

75/25 to 90/10 CO₂/Ar
(spray transfer)

CARBON STEEL

100% CO₂

75/25 to 90/10 CO₂/Ar
(spray transfer)

LOW-ALLOY STEEL

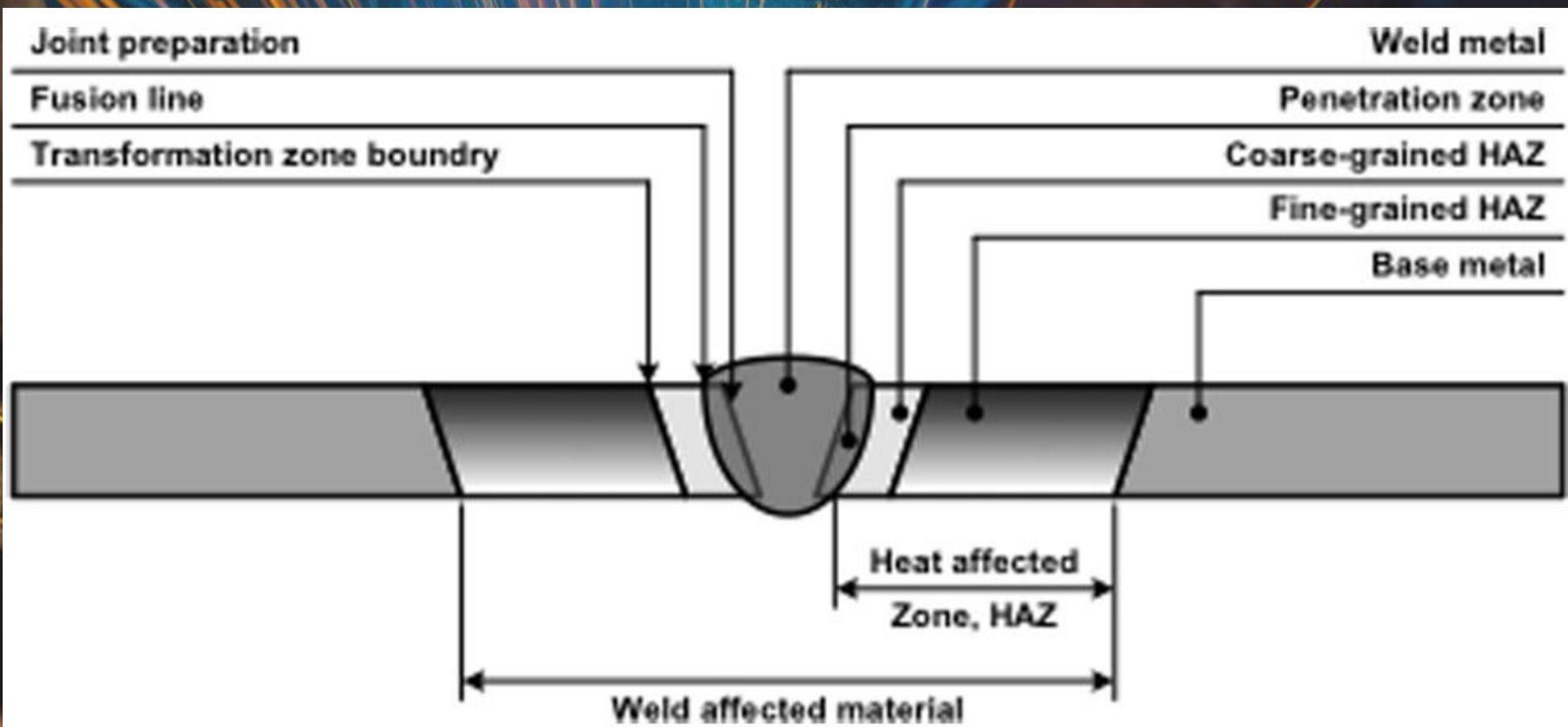
98/2 Ar/O₂

—

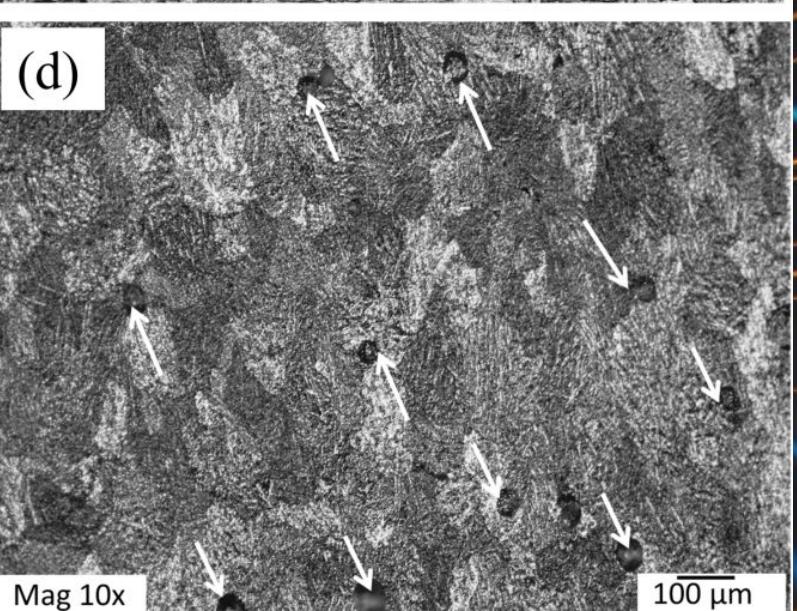
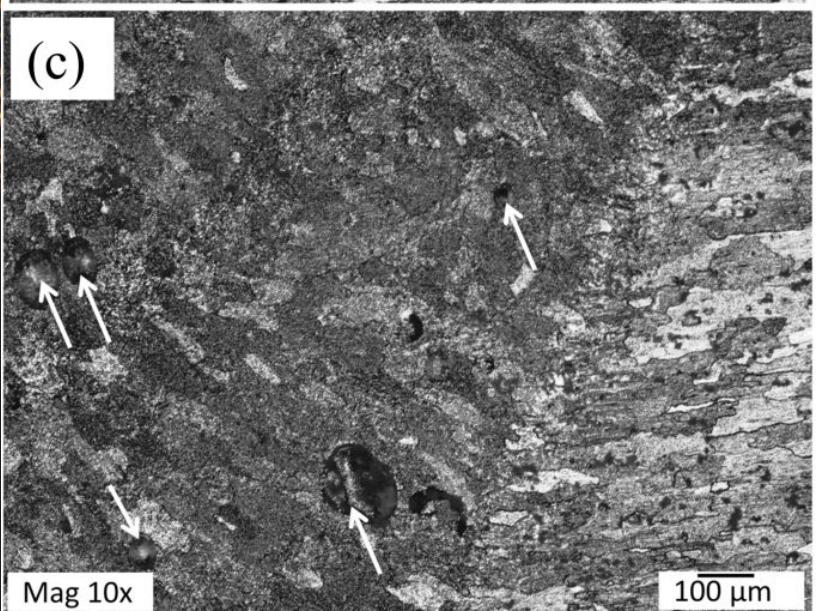
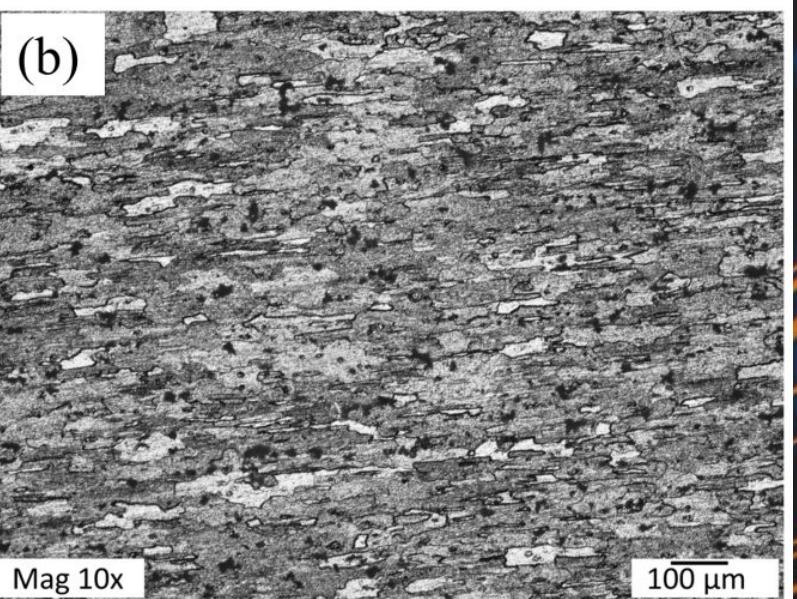
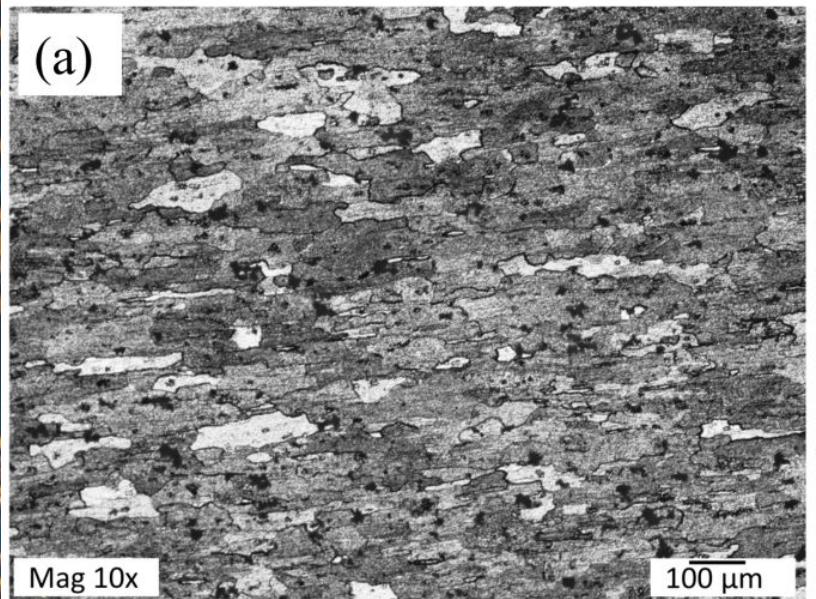
STAINLESS STEEL

98/2 Ar/CO₂

98/2 Ar/O₂,
(extra-low carbon con-
tent)



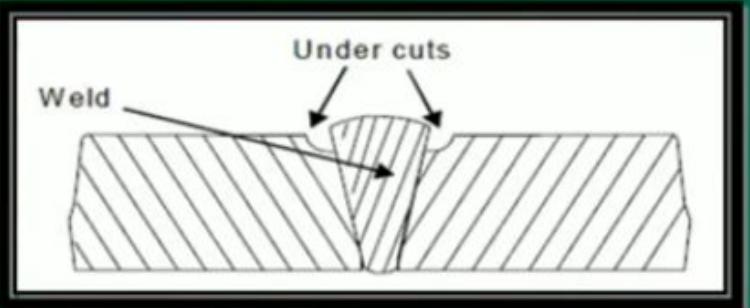
Different zones (AA 5754 Alloy)



- ❖ **Unfiled grooves present along the edges of the weld**

Causes

- Improper Welding Technique
- Excessive Welding Current
- Incorrect Manipulation of Electrode while depositing the weld bead.



Remedy

- Use Large Electrodes
- Use Moderate Current and move the weld torch slowly over the Work Piece.
- Place electrode at safe distance from the interface of Work piece.



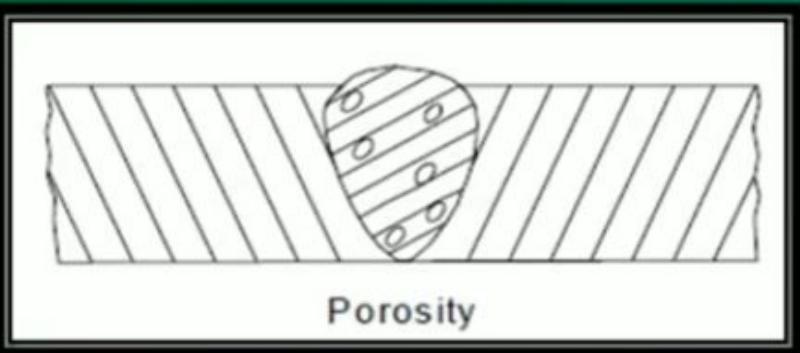
- ❖ Cavities or Pores caused due to entrapped gases in the molten metal during the Solidification process.

Causes

- Contaminated gases in the molten metal
- Inadequate Shielding.
- Unstable Arc
- Small arc gap
- Poor Welding Technique.

Remedy

- Proper selection electrodes and filler materials.
- Decreasing the speed of the welding torch.



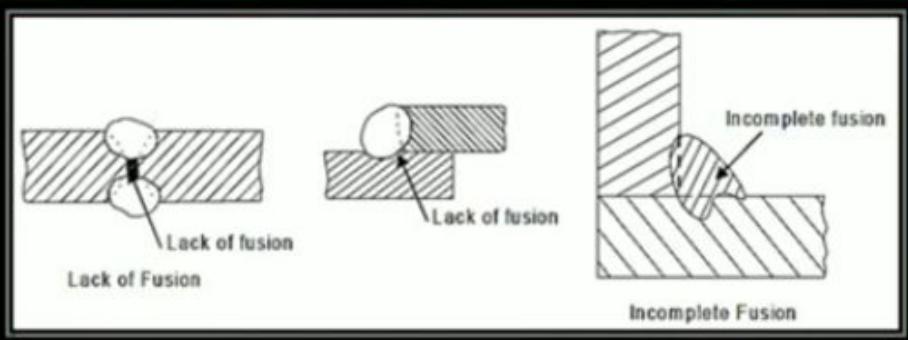
❖ Discontinuity in the Weld Zone.

Causes

- Improper Penetration of the Joint.
- Wrong Design of the Joint
- Incorporating incorrect Welding Technique

Remedy

- Supplying Low Electric Current than required.
- Cleaning the Joint properly



These consist of metal that has flowed on to the parent metal without fusing with it. The defect is due to

- (a) *Contamination of the surface of the parent metal*
- (b) *Insufficient heat*



❖ **Drops of Metal expelled from the weld which sticks to the welding surface.**

Causes

- High Welding Current .
- Long Arc.
- Incorrect Polarity of the arc blow
- Improper Gas Shielding

Remedy

- Decreasing the Welding Current and Arc Length.
- Using arc having correct Polarity.
- Checking the correct Shielding gas type and its flow rate.



➤ It is where the weld metal protrudes through the root of the weld. It is caused by

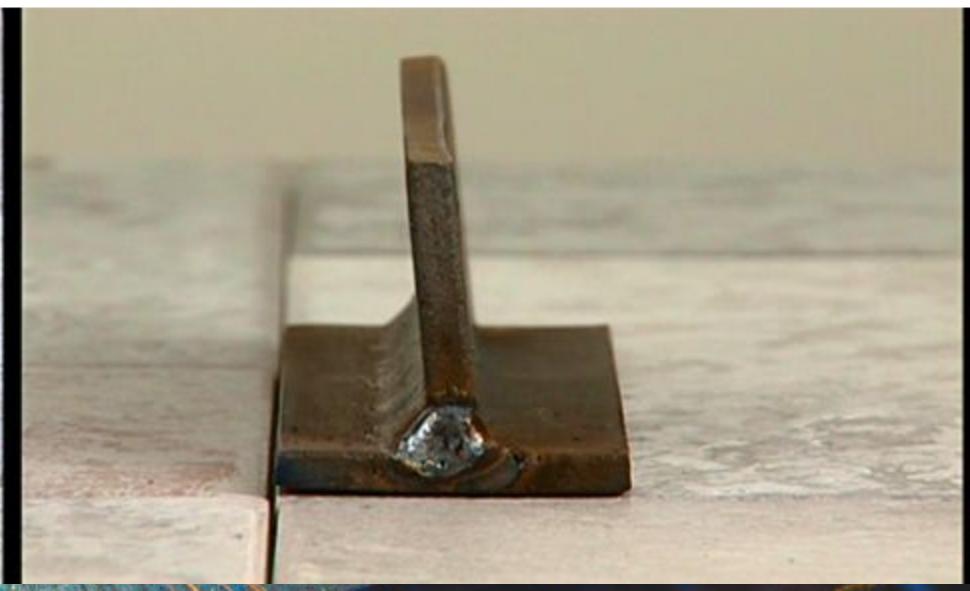
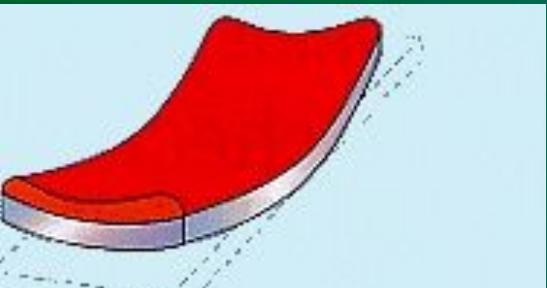
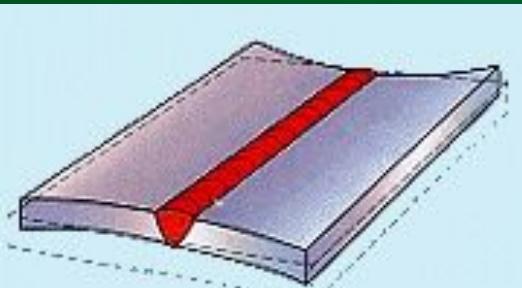
- (a) *Incorrect edge preparation*
- (b) *Too big a heat concentration*
- (c) *Too slow a travel.*



- If the width of weld bead deposited is not uniform or straight, then the weld bead is termed as poor.
- It is due to *improper arc length, improper welding technique, damaged electrode coating and poor electrode and earthing connections*.

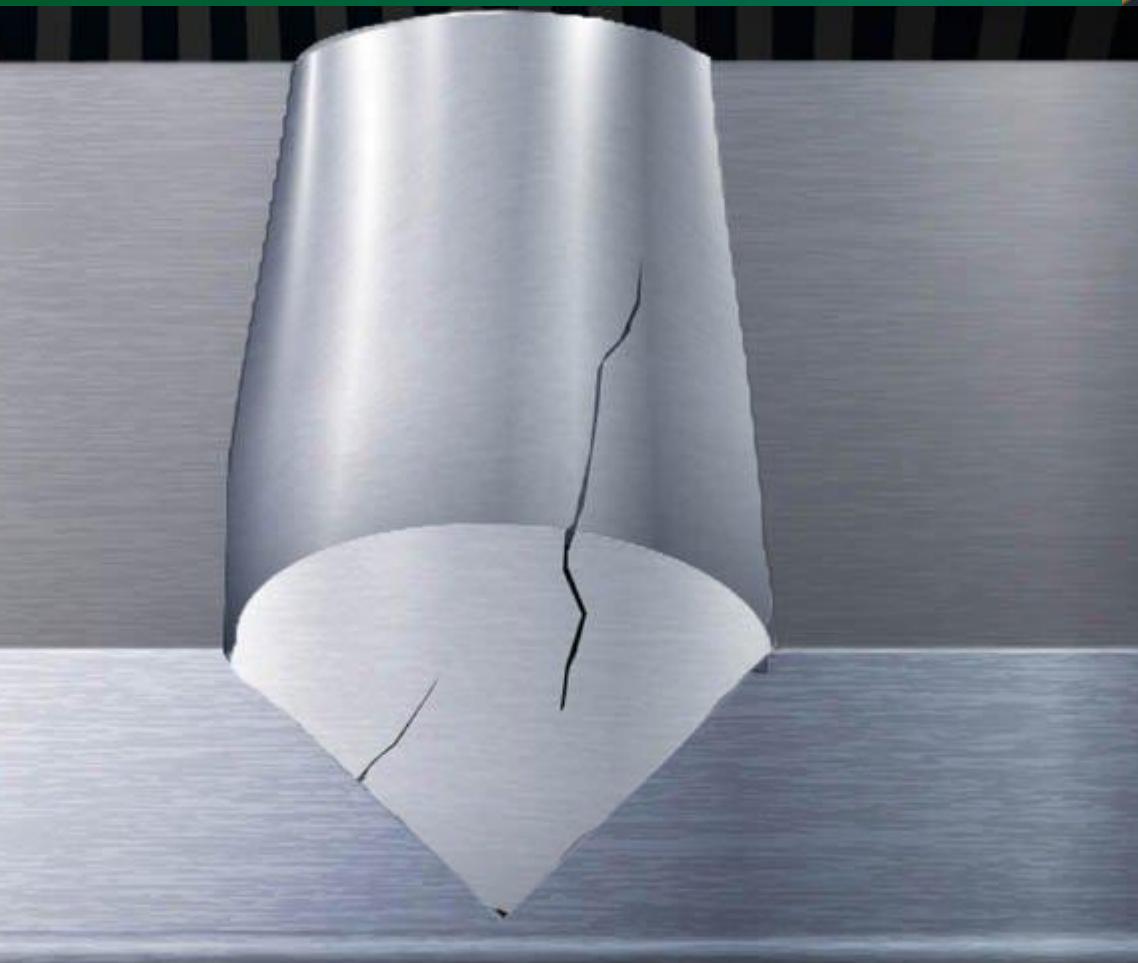
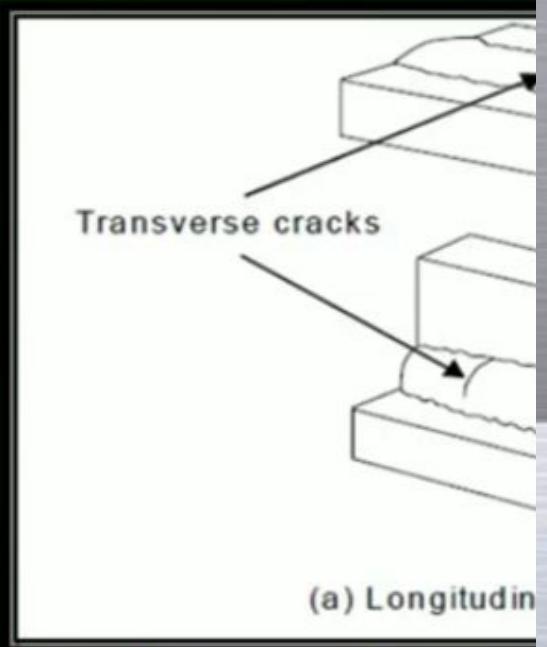


- Distortion is due to high cooling rate, small diameter electrode, poor clamping and slow arc travel speed.

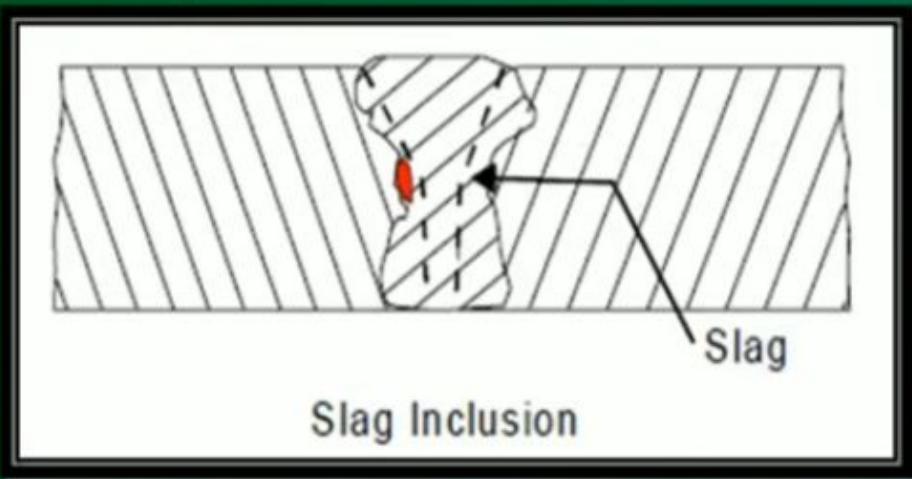


It is the **formation of cracks either in the weld metal or in the parent metal**. It is due to

- (a) *Unsuitable*
- (b) *Bad welding*



It is the **entrapment of slag or other impurities in the weld**. It is caused by



- (a) Slag from previous runs not being cleaned away,
- (b) Insufficient cleaning and preparation of the base metal before welding commences.

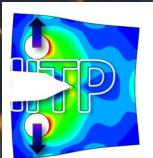
Protect yourself and others from potential hazards including:

- *Fumes and Gases*
- *Electric Shock*
- *Arc Rays*
- *Fire and Explosion Hazards*
- *Noise*
- *Hot objects*





- Fumes and gases can be hazardous to your health
- Keep your head out of the fumes
- Use enough ventilation, exhaust at the arc, or both, to keep fumes and gases from your breathing zone and the general area
- See product labeling and MSDS for ventilation and respirator requirements



Electric shock



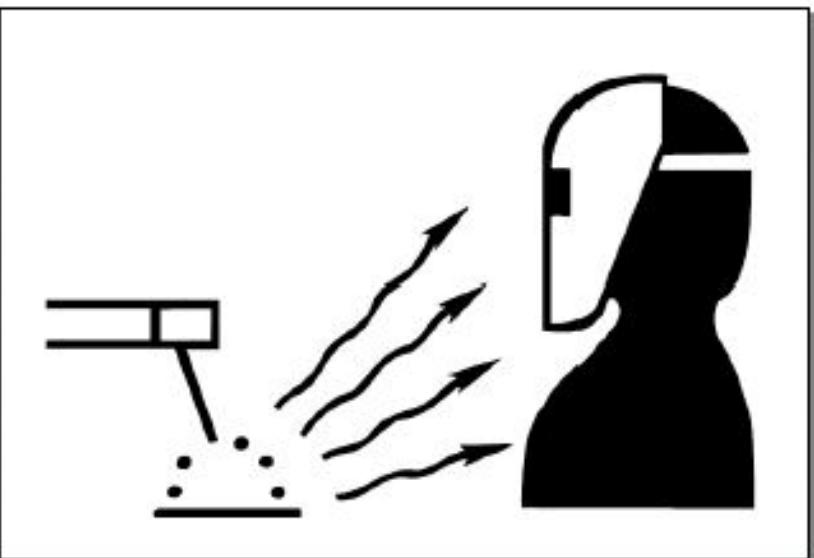
- Electric shock can kill
- Do not touch live electrical parts
 - Primary Voltage – 230, 460 volt input power
 - Secondary Voltage – 6 to 100 volts for welding
- Insulate yourself from work and ground
- Follow all warnings on welding equipment



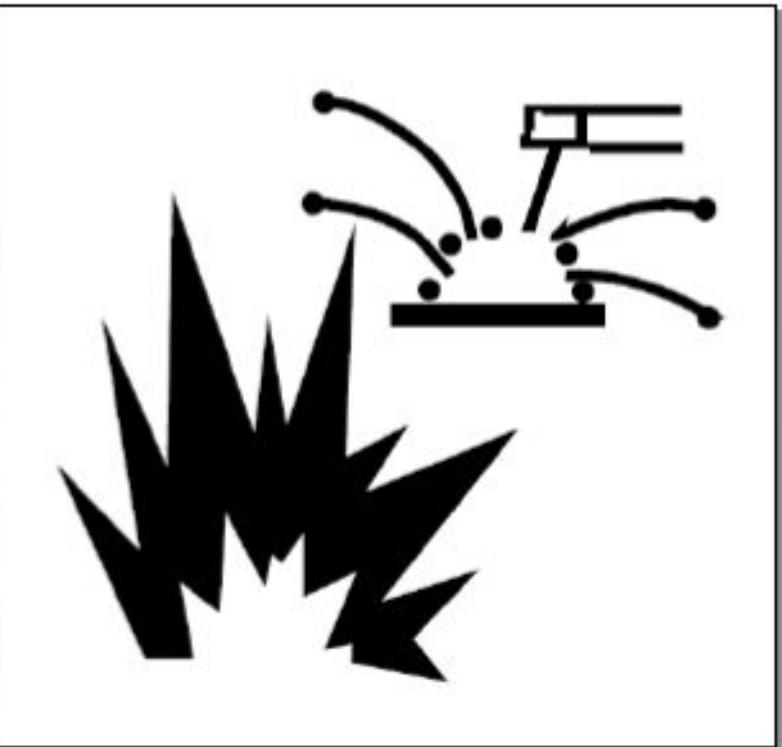
Do not make repairs
yourself, alert your
instructor immediately!

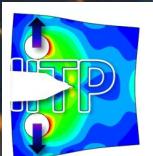
Arc rays

- Arc rays can injure eyes and burn skin
- The welding arc is brighter than the sun
- Precaution must be taken to protect your eyes and skin from UV radiation
- Wear correct eye and body protection



- Welding sparks can cause fires and explosions
- Sparks and spatter from the welding arc can spray up to 35 feet from your work
- Flammable materials should be removed from the welding area or shielded from sparks and spatter
- Have a fire extinguisher ready
- Inspect area for fires 30 minutes after welding





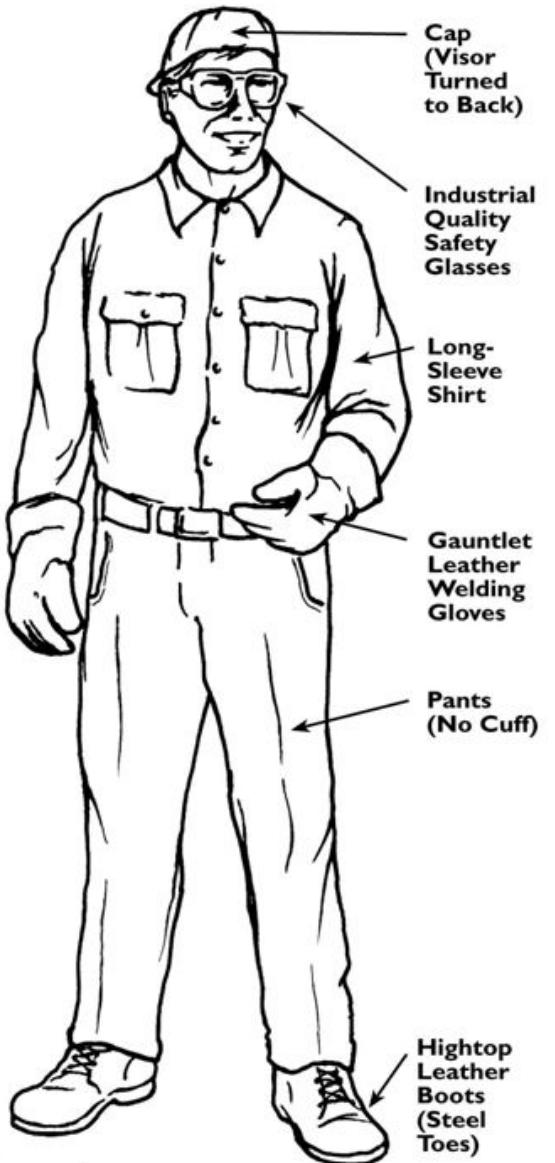
noise

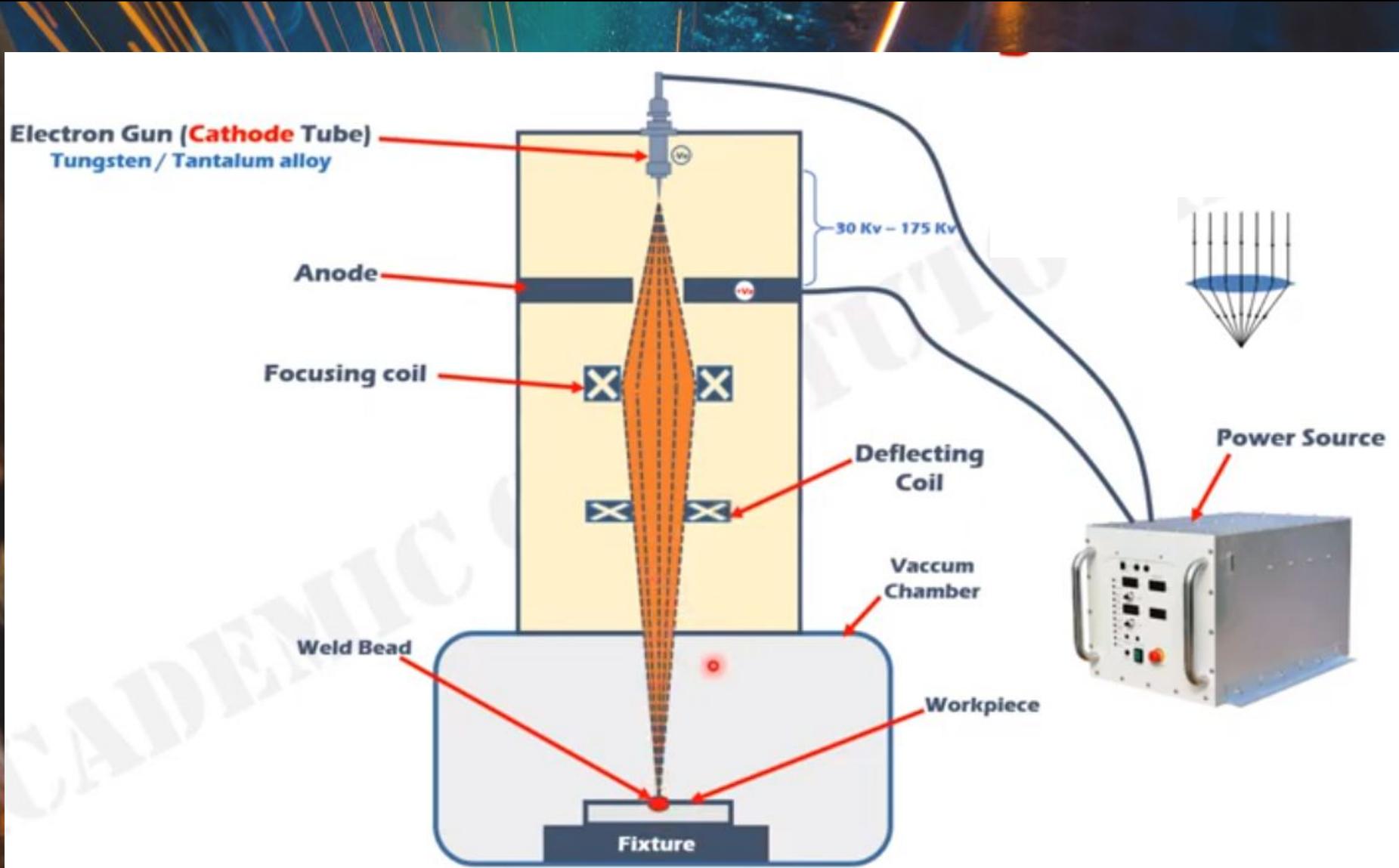


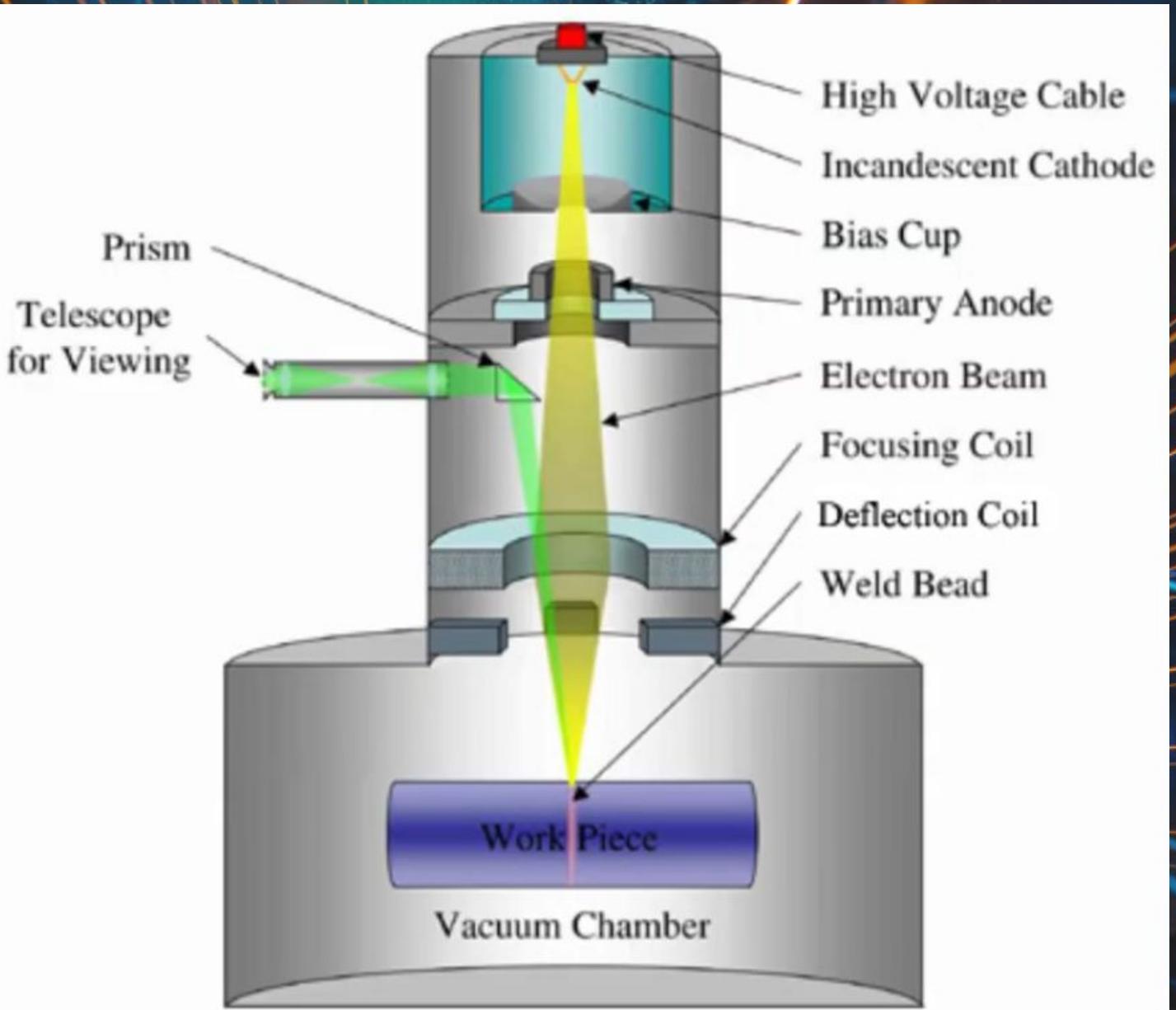
- Loud noises can damage your hearing
- Keep loud noises at a safe level by using proper hearing protection such as:
 - Ear plugs
 - Ear muffs

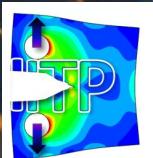


Proper Attire

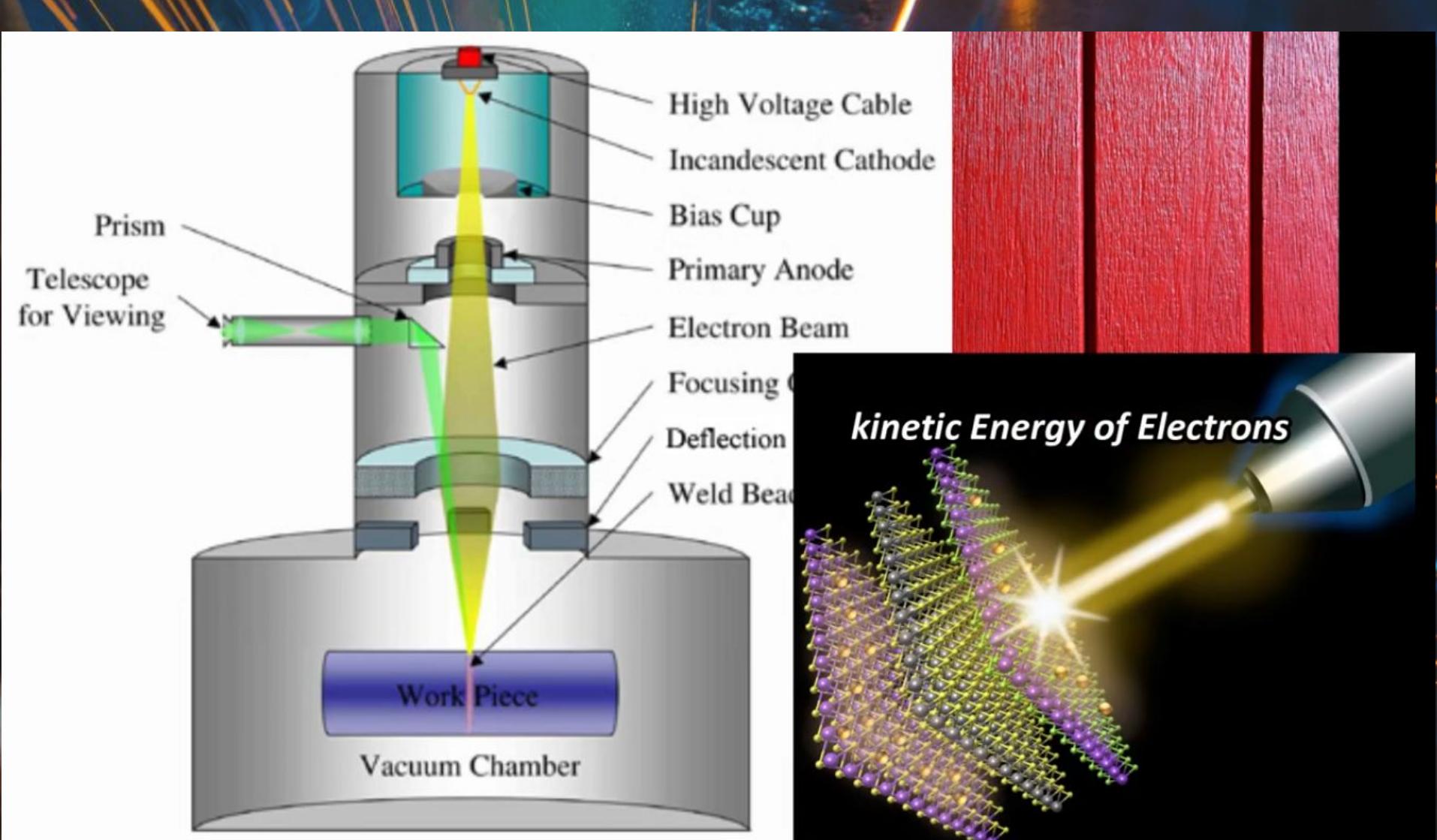


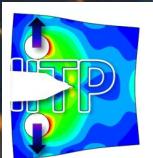




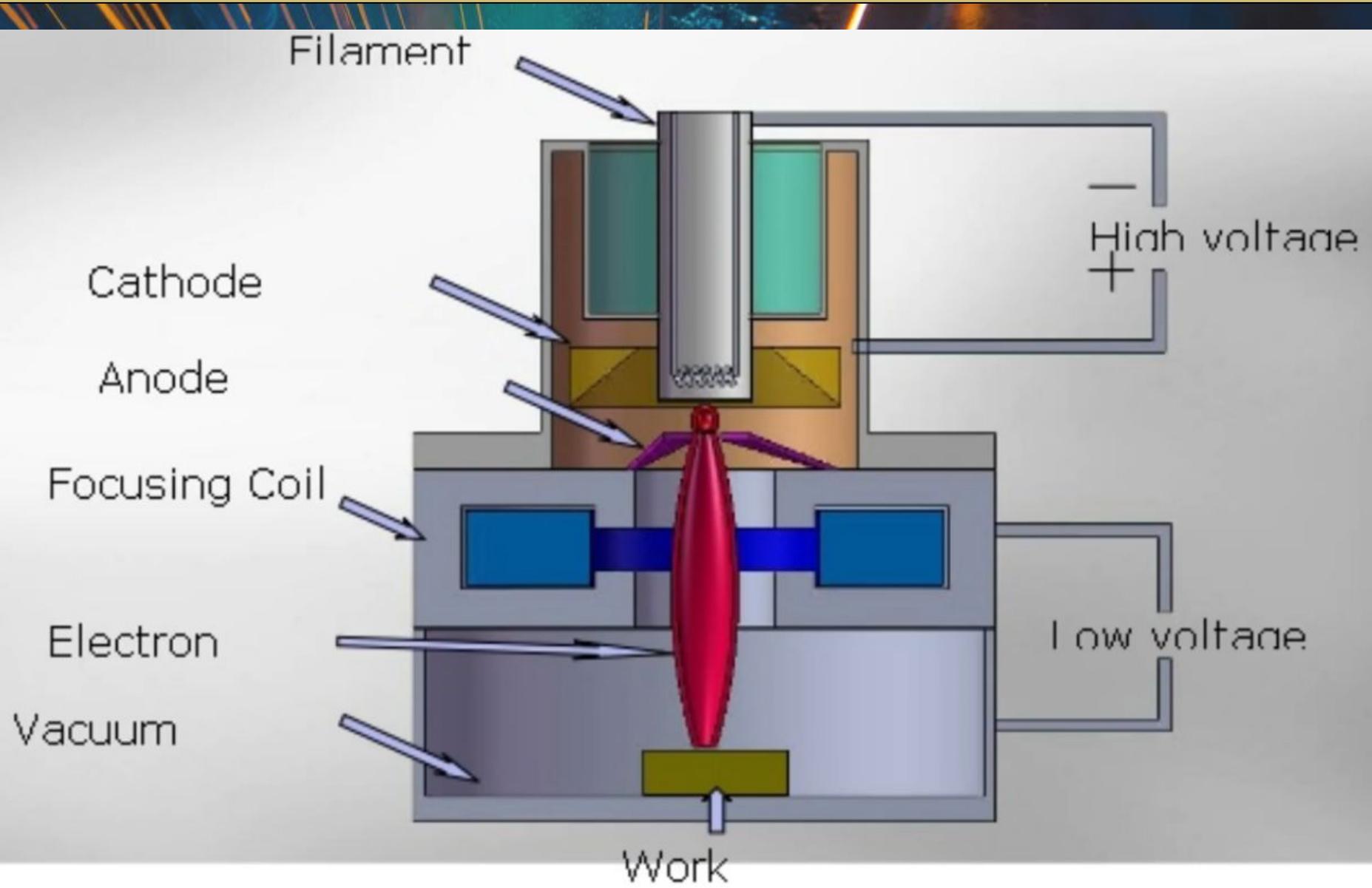


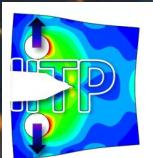
EBW: Electro beam welding





EBW: Electro beam welding





- Automotive industries
- Aircraft and space industries
- Mechanical engineering
- Tool construction
- Nuclear power industries
- Power plants
- Fine mechanics and electrical
- Industries
- Job shop

It can weld both similar and dissimilar metals.

It provides high metal joining rate.

Low operating cost because no filler material and flux are used.

It provide high finish welding surface.

It can used to weld hard materials.

Less welding defects occur due to whole process carried out in vacuum.



High capital or set up cost.

High skilled labor required.

Frequently maintenance required.

Work pieces size is limited according to vacuum chamber.

It cannot do at site due to vacuum.





- Laser beam equipment consists of a cylindrical ruby crystal with both the ends made absolutely parallel to each other. Ruby is aluminum oxide (AlO_2) with chromium dispersed throughout it.
- One end of the crystal is coated with a mirror so that light can be reflected back and forth through the crystal. This causes the light to undergo stimulated emission of radiation, which is then focused onto the workpiece.
- The ruby crystal is surrounded by a helical flash tube containing inert gas ‘xenon’ which itself in turn is surrounded by a ‘reflector’ to maximize the intensity of the incident light on the ruby crystal. The flash tube converts electrical energy into light energy.

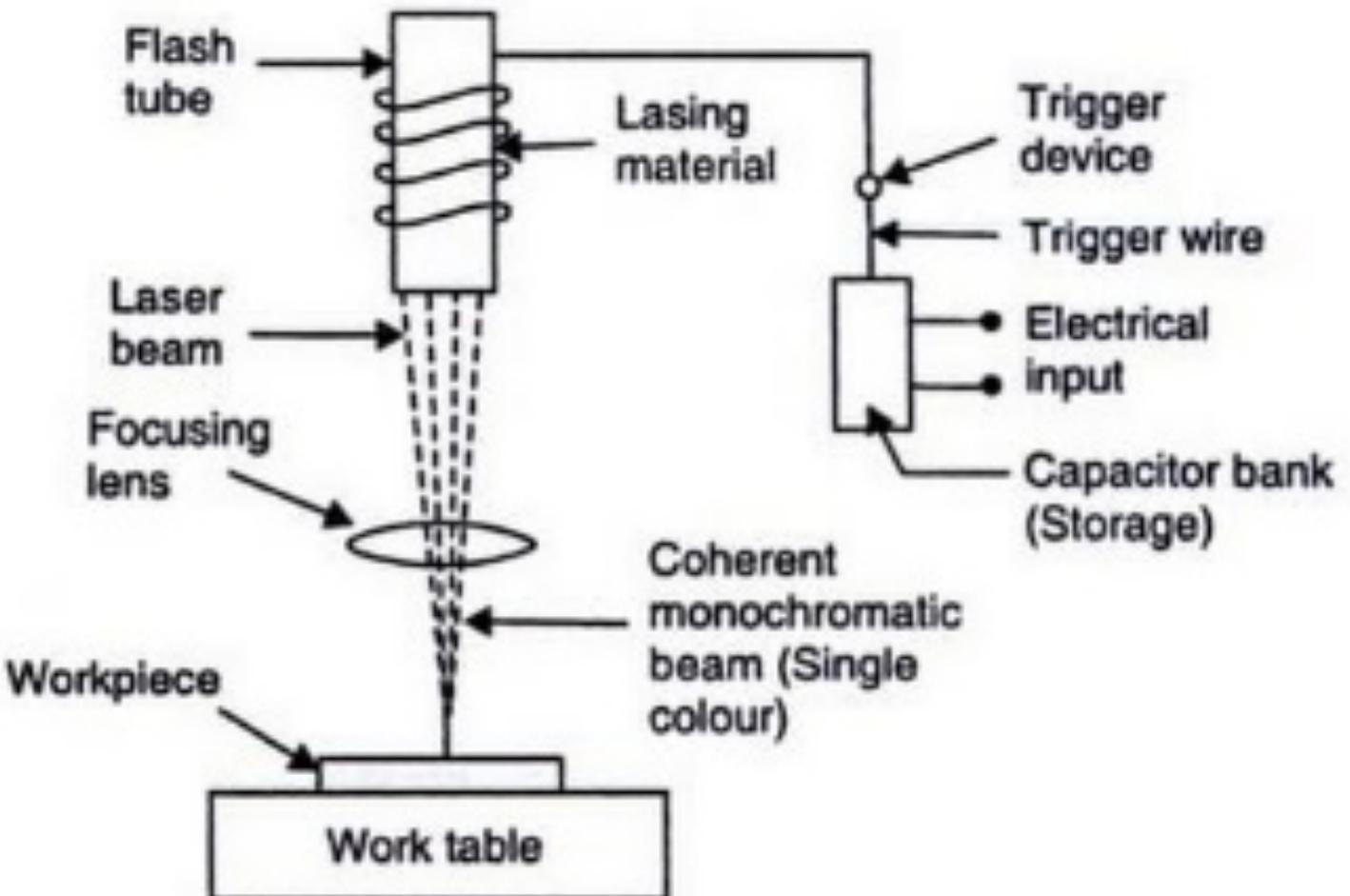
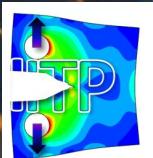


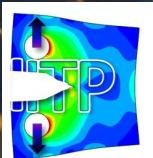
Fig. 2.43. Laser beam welding.



applications



- Electronic, Automotive & food processing
- Spot welds
- Vacuum components are welded easily
- Medical equipment
- Carbon steels & ferrous materials are welded
- Ideal for automation & robotics
- Used to weld IC to plates
- In aircraft industry to weld light gauge materials
- Cu, Ni, Al, Ss, W, Ti, Zr, Ta Columium etc
- Wire to wire, sheet to sheet, tube to sheet & small diameter stud welds.

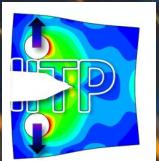


Advantages

- Similar and dissimilar metals can be welded easily.
- Laser beam can be controlled to a great precision and hence, the welding spots could also be located precisely. Certain locations in the material that are difficult-to-reach can be welded easily by this process.
- Heating and cooling rates are much higher in this process. Also, heat affected zone is very small. Hence, the process is ideal for locations which are surrounded by heat sensitive components.
- Clean weld joints can be obtained by this process.

Disadvantages

- Slow welding speeds (25 - 250 mm/min).
- Rapid cooling rate cause problems such as cracking in high carbon steels.
- High equipment costs.



Hybrid welding

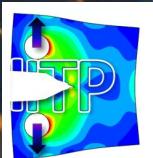


Laser-Hybrid welding is a combination of a laser process and an arc welding process, usually gas metal arc welding (GMAW).

A focused laser beam and the GMAW arc work together in a shared weld pool.

The filler material is introduced via the GMAW process.

The interaction between the laser process and the GMAW process creates an extremely stable welding process with a high deposition rate and a high degree of thermal efficiency.



Welding

Application of gas welding

Gas welding is used in a variety of industries. Here is a list of some of the most common applications of gas welding.

Repair works: One of the most common applications of gas welding is for repair works.

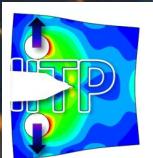
Fabrication of sheet metal: Thin to medium sheet metals are easily weld using gas welding.

Aircraft industry: Oxy-Acetylene welding is used in joining various aircraft parts.

Automotive industry: Used to weld parts of the frame and the chassis.

Joining High carbon Steel: Gas welding is very effective in melting high carbon steel.

Gas welding



Welding

Advantages of gas welding

Certain key features of gas welding make it so popular in the field. We will discuss some of them here.

Weld ferrous and non-ferrous metals: One of the great strengths of gas welding is that it can weld non-ferrous and ferrous metals together.

No requirement for electricity: When we compare gas welding to the other popular weld methods like arc welding, gas welding does not require any electricity to operate. Hence, you can use gas welding in places that do not have access to electricity.

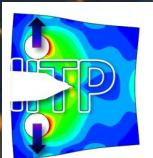
Cheap Equipment costs: The initial capital for gas welding is very low as it doesn't require specialized machinery.

Doesn't require specialized labor: Gas welding doesn't require highly specialized labor. This makes it easier to find gas welders, as well as keeps the labor charge low.

Portable equipment: The whole setup for Gas Welding is easily portable.

Gas Welding





Welding Torch

Pressure Regulators

Disadvantages of gas welding

The popular term “no one-size-fits-all” is true for gas welding too. These are some of the disadvantages of using gas welding. These include:

Not suitable for thick sections

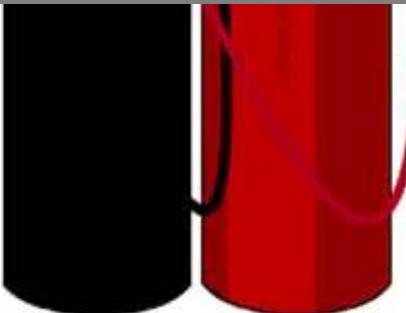
Cannot be used for high strength steel

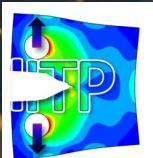
The slow rate of heating

Cannot reach the temperatures of arc welding

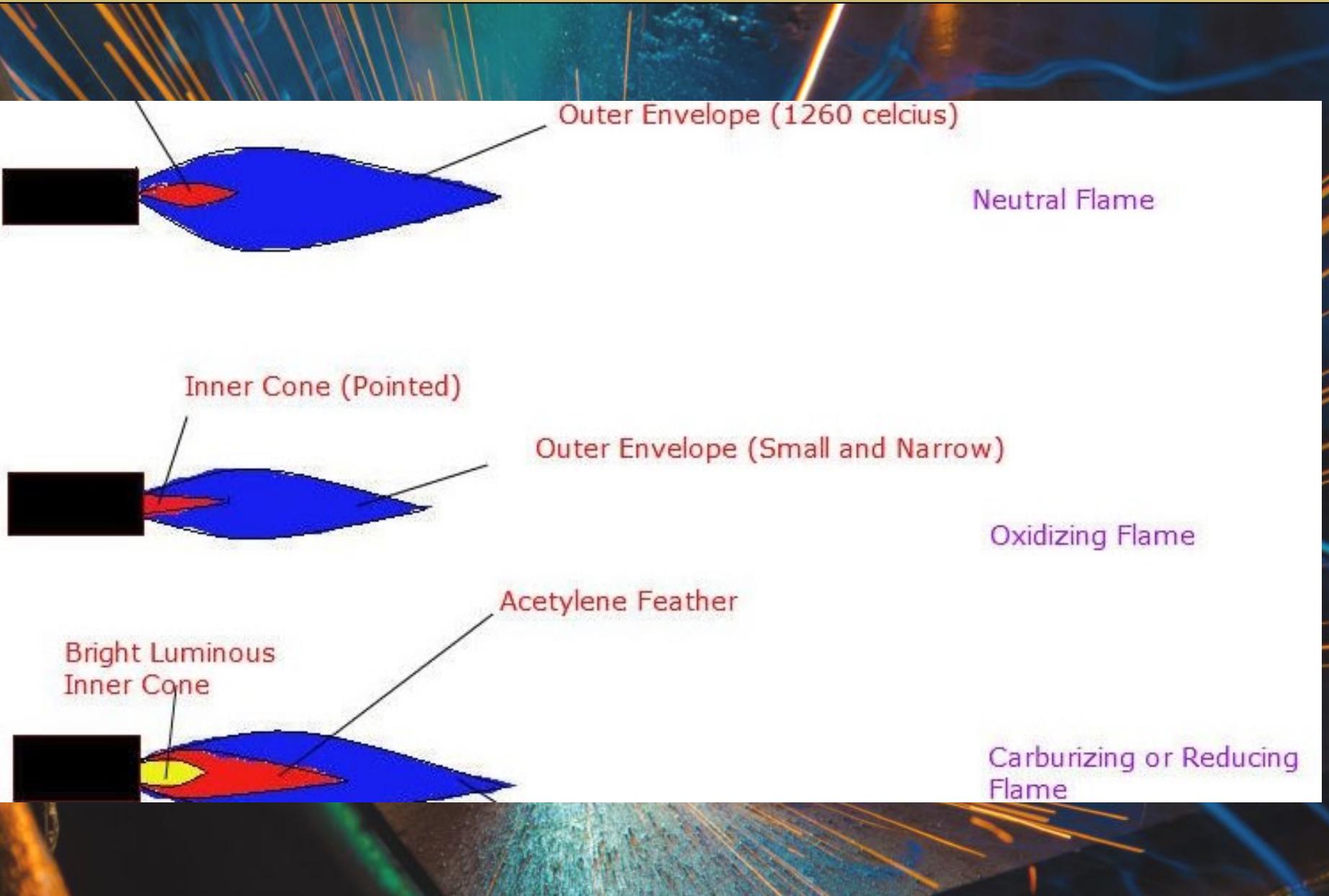
Doesn't have a dedicated flux shielding system

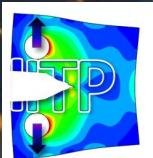
Gas Welding





Flames: Oxyacetylene welding





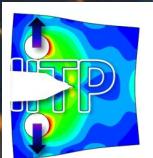
Friction stir welding



Rot
cre
wel



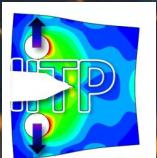
- FSW is mostly used in aircraft industries for welding wings, fuel tanks, aircraft structure etc.
- Used in marine industries for structure work.
- Used in automotive industries to weld wheel rims, chassis, fuel tanks and other structure work.
- It is used in chemical industries for joining pipelines, heat exchanger, **air conditioner** etc.
- Friction stir welding is also used in electronic industries for joining bus bar, aluminum to copper, connectors and other electronic equipment's.
- It is widely used in fabrication industries.



Advantages:fsw



- It is a solid state welding so does not use flux, filler metal etc.
- FSW can be used to weld both similar and dissimilar metals.
- Fine grain size and quality weld can be obtain by this process
- Lower power consumption due to absence of external heating.
- Highly automated.
- Little maintenance required.
- Large welding joint design available and it can weld in all direction.
- Easy to operate and does not involve any environmental pollution.



Disadvantages: fsw



- Complicated or special **fixture** arrangement required.
- It creates a visible hole in welding plates.
- High initial or setup cost.
- It is less flexible compare to **arc welding process**.
- FSW cannot make filler joints.
- Non Forgeable material cannot be weld.

A form of **resistance welding**, spot welding is one of the

