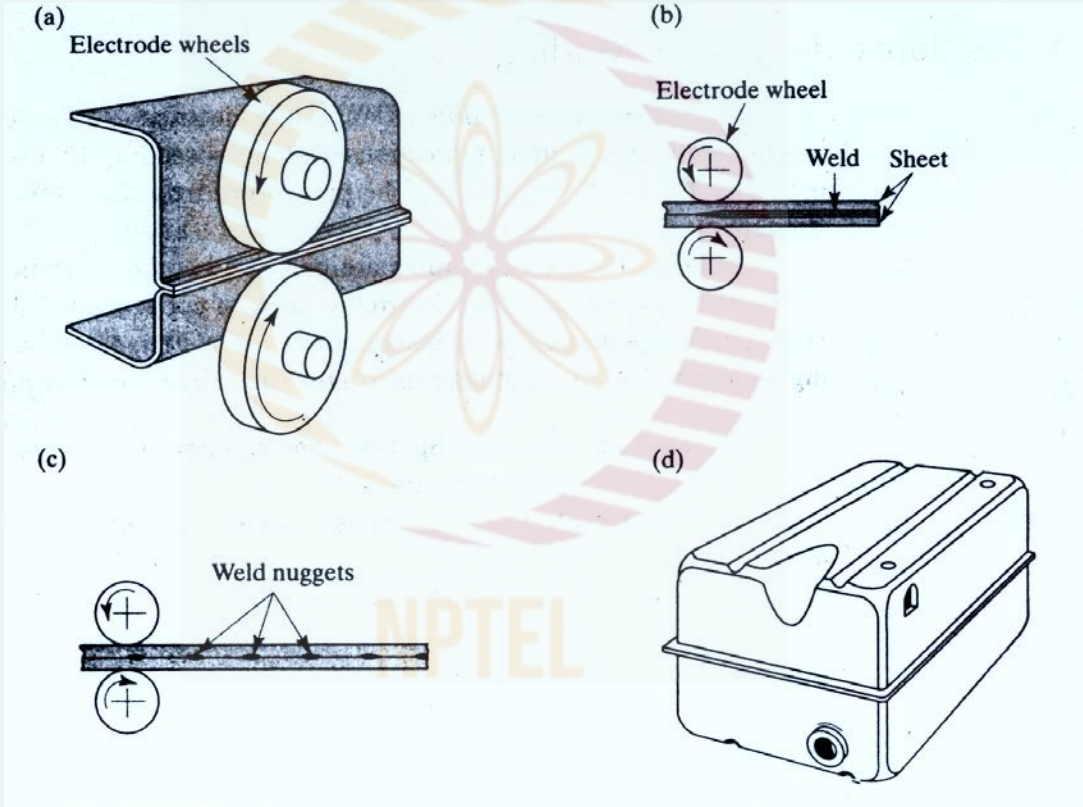
Various Welding Processes

Solid Phase Welding

Resistance Seam Welding



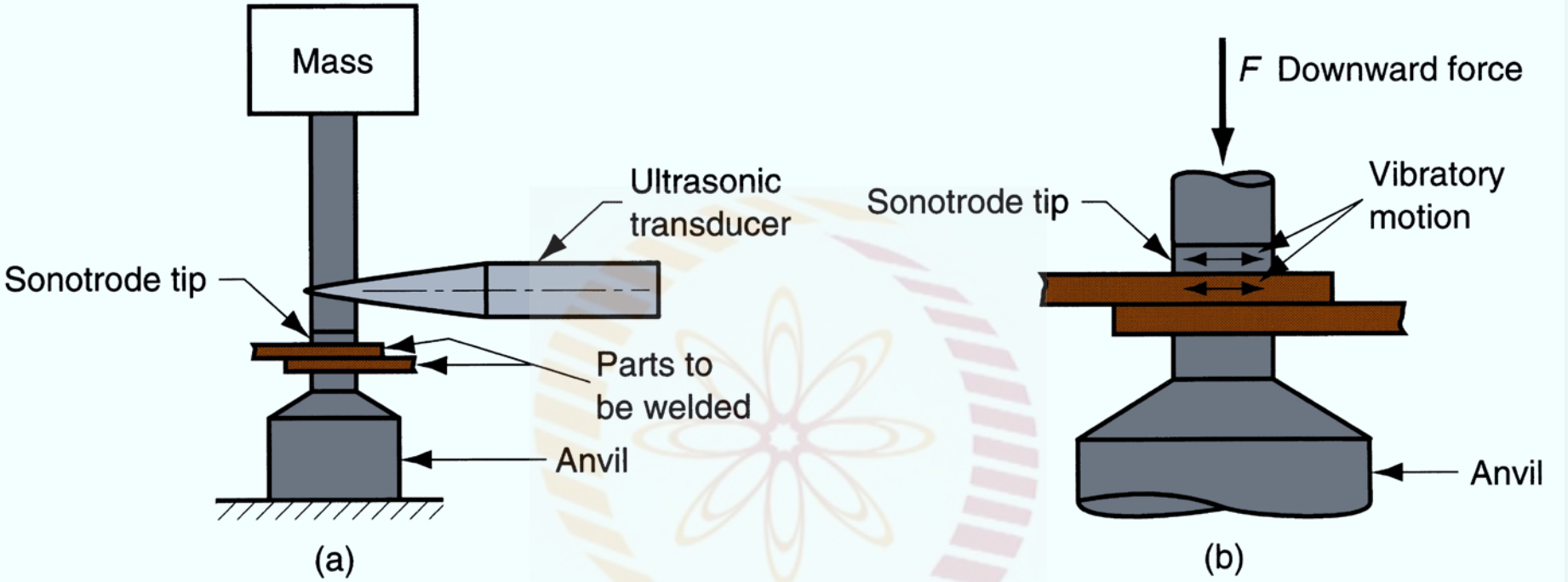
(a)Wheel electrodes, (b) Overlapping spot welds, (c) Spot weld, (d) Resistance welded gasoline tank

Ultrasonic Welding (USW)

Ultrasonic Welding Video

USW process in which two components are held together, and oscillatory shear stresses of ultrasonic frequency applied to interface cause coalescence

- Oscillatory motion breaks down any surface films to allow intimate contact and strong metallurgical bonding between surfaces
- Although heating of surfaces occurs, temperatures are well below T_m
- No filler metals, fluxes, or shielding gases
- Generally limited to lap joints on soft materials such as aluminum and copper



Ultrasonic welding (USW):
(a) general setup for a lap joint; and (b) close-up of weld area

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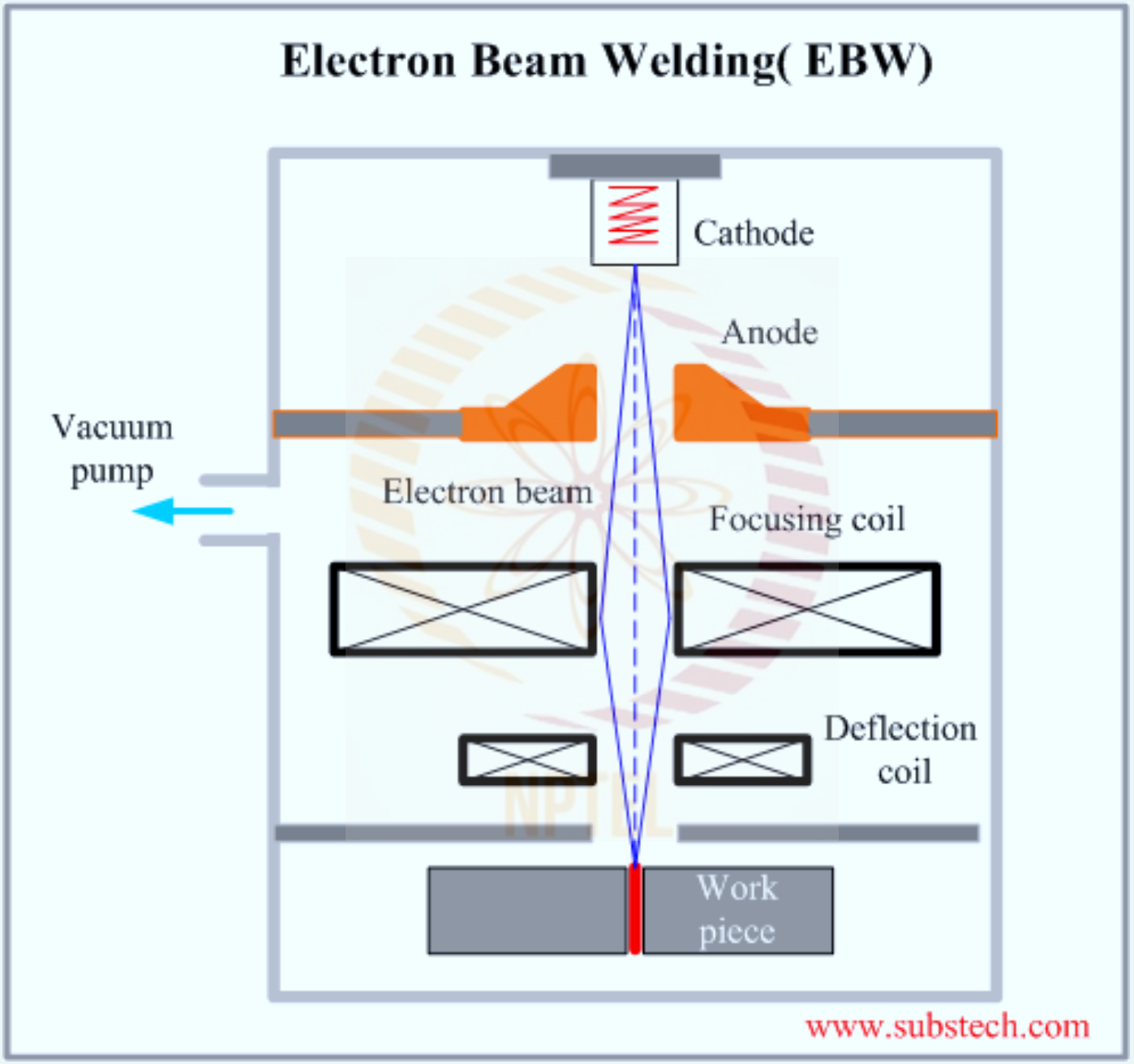
USW Applications

- Wire terminations and splicing in electrical and electronics industry (eliminates need for soldering)
- Assembly of aluminum sheet metal panels
- Welding of tubes to sheets in solar panels
- Small parts assembly tasks in automotive industry


Electron Beam Welding(EBW)
Cathode
Anode
Vacuum pump
Electron beam
Focusing coil
Deflection coil
Work piece
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Electron Beam Welding

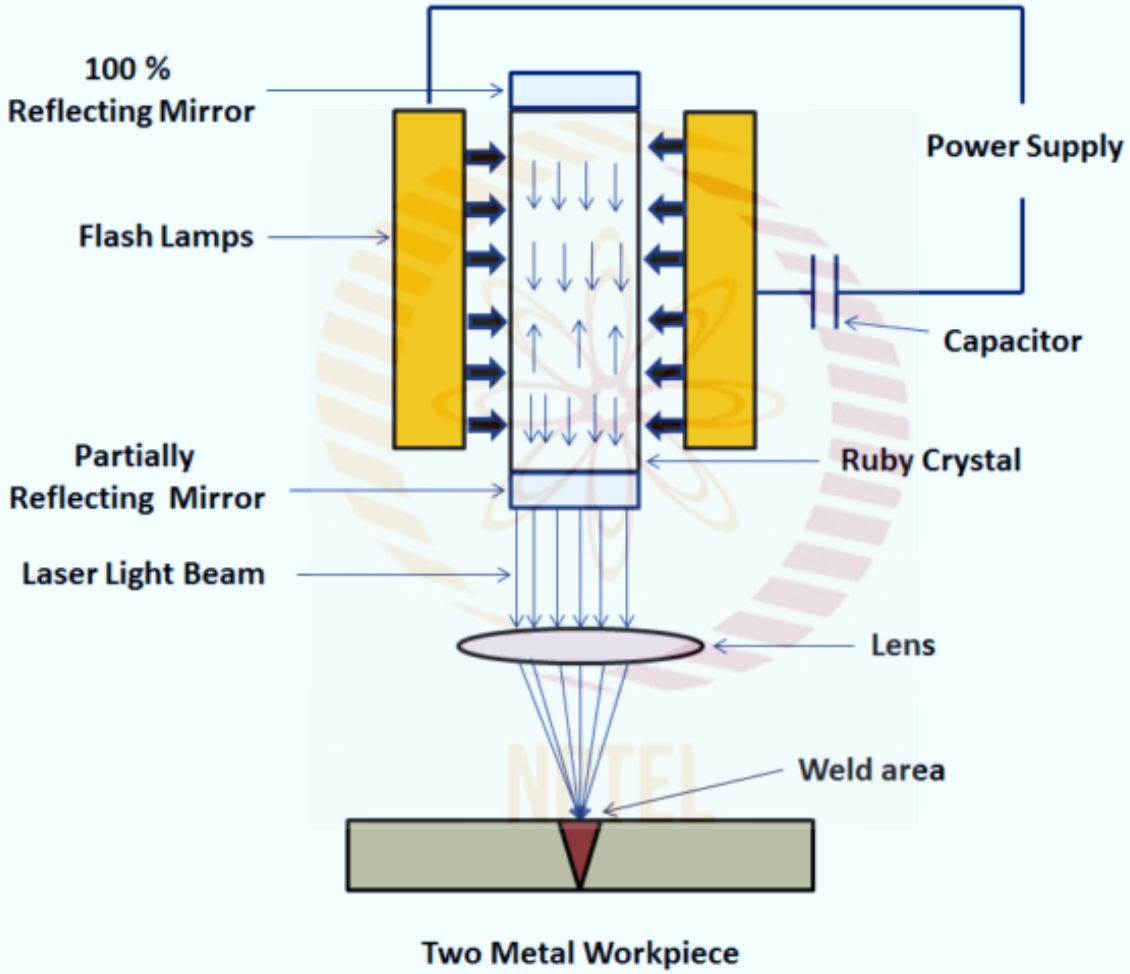
- The process uses a very high-intensity beam of electromagnetic energy as the heating source for welding in the form of electrons.
- The energy density is approximately 10^{10} to 10^{13} W/m^2 versus 5×10^6 to 5×10^8 W/m^2 for typical arc welding processes.
- Conversion of the kinetic energy of the electrons into heat occurs as these particles strike the workpiece, leading to melting and vaporization.
- Penetration can be high, producing deep, narrow, parallel-sided (high aspect) fusion zones with narrow heat-affected zones and minimal angular distortion due to nonuniform weld metal shrinkage or thermal expansion and contraction.

Electron Beam Welding

Working Principle

- Electron beams are produced in what is called a gun by thermionically extracting them from a heated filament or cathode and accelerating them across a high potential achieved using one or more annular anodes along a high-vacuum column. The stream of accelerated electrons is focused into a beam of very high energy density using a series of electromagnetic coils or lenses. The electrons then pass from the column to a work chamber to the workpieces to produce a weld.

Laser Beam Welding



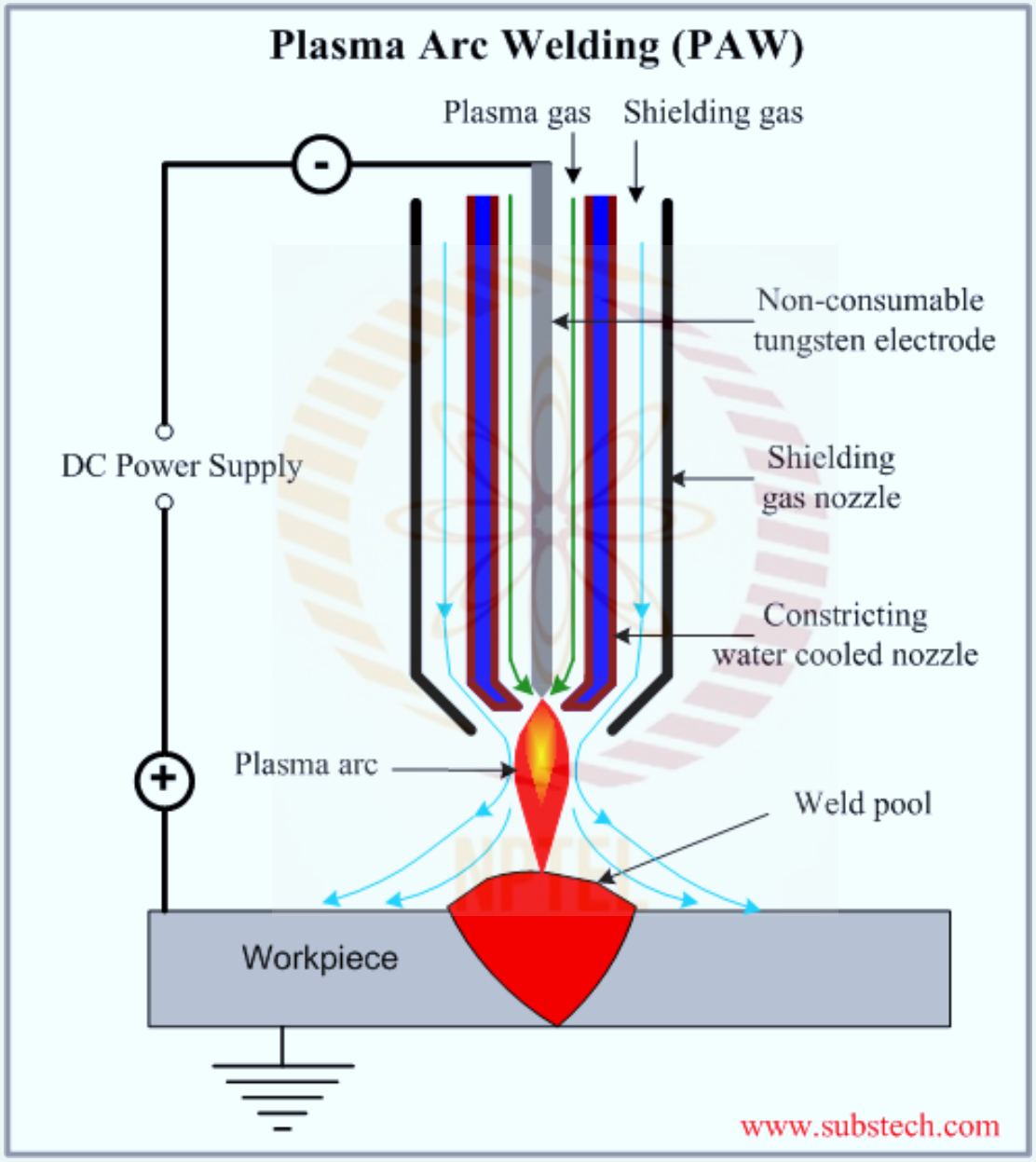
Laser Beam Welding

- The process uses a very high-intensity beam of electromagnetic energy as the heating source for welding in the form of photons.
- The energy density is approximately 10^{10} to 10^{13} W/m^2 versus *5* x 10^6 to *5* x 10^8 W/m^2 for typical arc welding processes.
- Conversion of the kinetic energy of the photons into heat occurs as these particles strike the workpiece, leading to melting and vaporization.
- Penetration can be high, producing deep, narrow, parallel-sided (high aspect) fusion zones with narrow heat-affected zones and minimal angular distortion due to nonuniform weld metal shrinkage or thermal expansion and contraction.

Laser Beam Welding

- Shielding for the LBW process is accomplished with inert gases, either in dry boxes or from special shrouds over the vicinity of the weld puddle, although the process could also be performed in vacuum.

NPTEL



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