LESSON PLAN

Date_____ Trade:- Welder

Name_____ Unit/Lesson:-Forty seven

Subject:- Hard facing: necessity, methods of preparation, various hard facing alloys and advantages of hard facing.

Motivation:- In previous lesson we discuss about Welding codes and standards. Reading of assembly drawing. Welding procedure specification and procedure qualification records.

PREPARATION

1) (Materials, Tools, Models, Charts and other aids)

INTRODUCTION: Hard facing mean hard the surface. In many jobs we use only surface area and due to wear and tear this area need hard facing.

Topic	Information Point	Spot Hint
Hard facing	Hard facing is a process to hard a metal surface.	
Preparation	We use grinding, machining, filing, chipping and sand blasting to clean surface before hard facing	

Major Surface Treatments	▪ Finishing and Polishing – covered previously
	▪ Coatings
	  ▪ Conversion Coatings (oxidation, anodizing)
	  ▪ Thermal Coatings (carburizing – flame spraying)
	  ▪ Metal Coatings (electrochemical, electroless)
	  ▪ Deposition
	  ▪ Physical Vapor Deposition
	  ▪ Chemical Vapor Deposition
	  ▪ Organic	

Conversion Coatings	▪ Oxidation ▪ Phosphate Coatings Chrome Coatings	
Conversion Coatings - Oxidation	➢ Oxidation o Not all oxides are detrimental – many are tightly adhering leading to passivation and hardening of surface ▪ Al_2O_3 ▪ Chromium in Stainless steel rapidly corrodes to passivate the surface ➢ Gun-bluing o Heat steel to 700 deg F in steam or oil o Blue coating offers some corrosion resistance, but little wear benefit ➢ Chemical Baths – similar in nature to gun-bluing ➢ Black Oxide – chemical application	

	○ Typically applied to steel, copper and stainless steel ➢ Anodizing – electrochemical conversion ○ Usually done to Aluminum ○ 2-25 mm thick typically ○ Multiple colors possible ○ Improved Corrosion and Wear Resistance
Conversion Coatings – Phosphate Coating	▪ Immersion in a Zn-P bath with Phosphoric acid causes growth of a crystalline zinc phosphate layer ▪ Iron, Zinc or Manganese Phosphate layer formed ▪ Typically applied to C-steel, low alloy steel and cast irons ▪ Sometimes applied to Zinc, Cadmium, Aluminum and Tin ▪ Typically very thin ~ 2.5 mm
Thermal Treatments ▪	▪ Surface Heat Treatment ▪ Diffusion Coating ▪ Hot-Dip Coatings ▪ Weld Overlay Coatings ▪
▪ Thermal Treatments – Surface Heat Treatment	▪ Basic concept is to heat the surface to austenitic range, then quench it to form surface martensite - workpiece is steel ▪ Heating Methods ▪ Flame Treatment ▪ Induction Heating ▪ Copper coil wraps around part to heat by induction ▪ Electron Beam or Laser Beam Hardening ▪ Typically heat small area and allow the bulk solid heat capacity to quench the small heated area
Thermal Treatments – Diffusion Coating	▪ With low carbon steel, the surface can be enriched by diffusion of C or N into surface ▪ Carburizing ▪ Heat steel to austenitic range (850-950 ºC) in a carbon rich environment, then quench and temper ▪ Nitriding ▪ Nitrogen diffusion into steels occurs around 500-560 ºC to form a thin hard surface ▪ Good for Cr, V, W, and Mo steels. Will embrittle surface of Aluminum. ▪ Metal Diffusion ▪ Chromizing – Chromium diffuses into surface to form corrosion resistant layer. ▪ Take care with carbon steels as surface will decarburize ▪ Aluminizing – Used to increase the high temperature corrosion resistance of steels and superalloys
Metal Coatings	▪ Electroplating ▪ Electroless Coatings ▪ Metallizing of Plastics and Ceramics
Metal Coatings -	▪ Used to increase wear and corrosion resistance

Electroplating	▪ Electrochemical process used to create a thin coating bonding to substrate ▪ Process is slow so coating thickness can be closely controlled (10-500 mm) ▪ Applications ▪ Tin and Zinc are deposited on steel for further working ▪ Zinc and Cadmium are deposited on parts for corrosion resistance (Cadmium is toxic and can not be used for food applications) ▪ Copper is deposited for electrical contacts ▪ Nickel for corrosion resistance ▪ Chromium can be used to impart wear resistance to dies and reduce adhesion to workpieces such as aluminum or zinc ▪ Precious metals for decoration or electronic devices
Metal Coatings – Electrode Coatings	▪ Part is submerged into an aqueous bath filled with metal salts, reducing agents and catalysts Catalysts reduce metal to ions to form the coating Excellent for complex geometries as deposition is uniform across surface regardless of geometry (except very sharp corners (0.4 mm radii))
Metal Coatings - Electrode Nickel Plating	▪ Has the appearance of stainless steel ▪ Autocatalytic immersion process ▪ Key characteristics: ▪ Heat treatable coating (to 68 Rc) very hard ▪ Non-porous ▪ Corrosion resistant ▪ .001" thick typical ▪ Withstand load to 45 ksi ▪ Can be applied to: ▪ steel and stainless steel, iron, aluminum, titanium, magnesium, copper, brass, bronze, and nickel
Electroless Nickel vs. Chrome Plating	

	ELECTROLESS NICKEL	**HARD CHROME**
METAL DISTRIBUTION	**VERY GOOD**	**POOR**
CORROSION RESISTANCE	**1,000 HOURS ASTM B117**	**400 HOURS ASTM B117**
HARDNESS: AS DEPOSITED HEAT TREAT	**48-52 Rc 70 Rc**	**64-69 Rc 48-52 Rc**
MELTING POINT	**1800°F**	**2900°F**
WEAR RESISTANCE	**GOOD**	**VERY GOOD**
CO-EFFICIENT OF FRICTION: DYNAMICSTATIC	**0.19 0.20**	**0.16 0.17**

DUCTILITY	**1-2%**	**Very Low Almost 0**
EFFLUENT COST	**RELATIVELY LOW**	**HIGH**
DEPOSITION RATE (PER HOUR PER HOUR)	**.0002 - .0003**	**.001 - .002**
EFFECTIVE OF HYDROGEN EMBRITTLEMENT ON PLATED COMPONENTS	**FAIR/NOT SERIOUS**	**USUALLY SERIOUS**

Metal Coatings – Metallizing of Plastics and Ceramics	▪ Poor adhesion is the major challenge (As in all coating processes, however it is more challenging in this case.) ▪ Applications ▪ Decorative (plumbing fixtures, automotive parts), reflectivity (headlights), electrical conduction (electronic touchpads), and EMF shielding
Vapor Deposition	▪ Physical Vapor Deposition (PVD) ▪ Thermal PVD ▪ Sputter Deposition ▪ Ion plating ▪ Chemical Vapor Deposition (CVD)

Chemical Vapor Deposition

- Deposition of a compound (or element) produced by a vapor-phase reduction between a reactive element and gas
- Produces by-products that must be removed from the process as well
- Process typically done at elevated temps (~900ºC)

Coating will crack upon cooling if large difference in thermal coefficients of expansion

- Plasma CVD done at 300-700ºC (reaction is activated by plasma)
  - Typical for tool coatings
- Applications Diamond Coating, Carburizing, Nitriding, Chromizing, Aluminizing and Siliconizing processes
- Semiconductor manufacturing

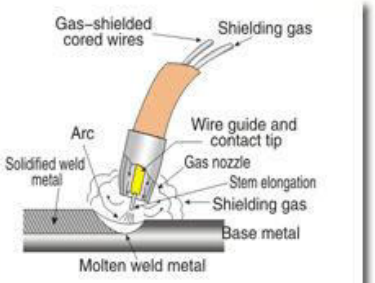
Table H-5
Hard Facing Processing

Process	Heat Source	Mode of Application	Hardfacing Alloy Form
Oxyfuel gas welding	Oxyfuel gas	Manual or automatic	Bare cast rods or powder
Shielded metal arc welding	Electric arc	Manual	Flux coated rods
Open arc welding	Electric arc	Semiautomatic	Flux cored tube wire
Gas tungsten arc welding	Inert gas shielded electric arc	Manual or automatic	Bare rods or wire
Submerged arc welding	Flux covered electric arc	Semiautomatic	Bare solid or tubular wire
Plasma transferred welding	Inert gas shielded plasma arc	Automatic	Powder, hot wire
Plasma arc welding	Inert gas shielded plasma arc	Manual or automatic	Same as GTAW
Spray and fuse	Oxyfuel gas	Manual	Powder
Plasma spray	Plasma arc	Manual or automatic	Powder
Detonation gun	Oxyacetylene detonation	Automatic	Powder

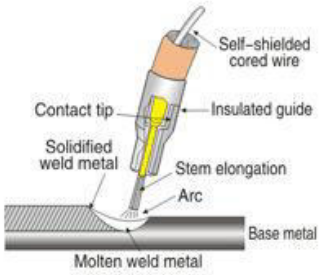
Leigong Classification Systerm

L X XX X

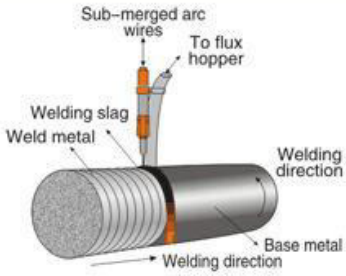
- Serial Number Of Wires
- Hardness Of Deposite Metal
- Welding Process
  - M: Submerged arc welding
  - Q: Gas-shielded arc welding
  - Z: Self-shielded arc welding
- Leigong Welding Alloys CO., LTD



Gas shielded arc



Self shielded arc



Submerged arc

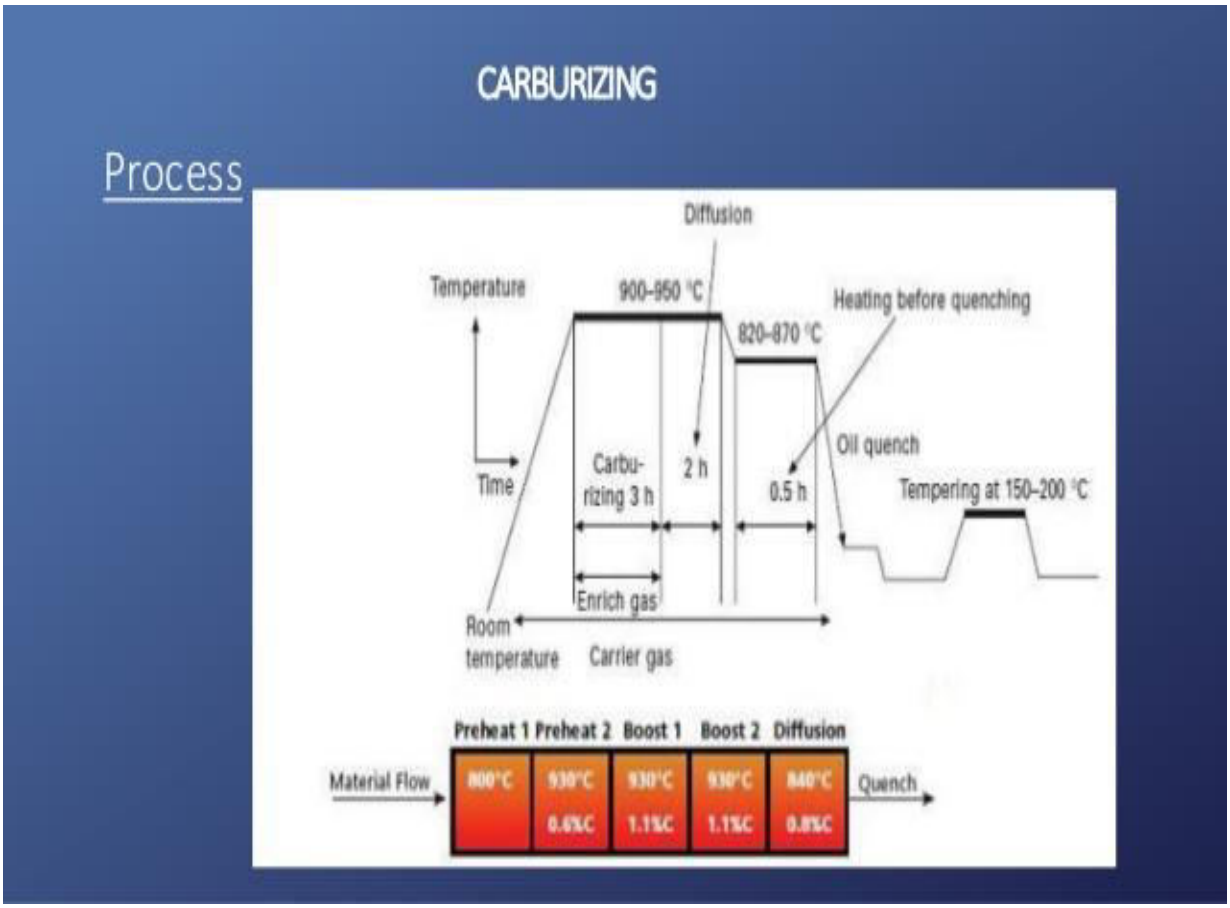


Table 1 – The characteristics of cobalt-based hardfacing alloys

Hardfacing Alloy	Oxidation Resistance	Wear Resistance	Brittleness	Weldability
Stellite 6	Good	Fair	Fair	Good
New Alloy	Better	Better	Fair	Good
Tribaloy T-400C	Better	Good	Fair	Fair
Tribaloy T-800	Good	Better	Very	Poor

Table 3-7 Results of Measurements of Oxide Content, Porosity, Microhardness and Almen N Strip Values.

Parameter	WC/CoCr	Cr_3C_2/NiCr	T-400
Oxide Content	< 1% @ 200X	< 1% @ 200X	< 1% @ 200X
Porosity	< 1% @ 400X	1.0 – 1.5% @ 400X	< 1% @ 400X
Microhardness	1150 HV	1115 HV	650 HV
Almen N	10.5	5.7	9.3

Questions:-

1. What is hard facing?
2. Why need hard surfacing and how many types of hard facing?
3. What is nickel coating?

Assignments:- **:-** Hard facing: necessity, methods of preparation, various hard facing alloys and advantages of hard facing.

Checked by…….. Instructor……..