A Worldwide review of technological advances during 1990's

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Surface finishing has never been more important than it is today for all high-tech and strategic industries - electronics, telecommunications, photo-optics, computers, aerospace, to mention a few. Without progress in surface finishing, there would be no production of ICs, laser components, CPUs, superconducting films, thin film products, etc. It is safe to say that almost every product requires surface finishing application.

Surface finishing is estimated to be Rs.2500-3000 crores/year industry employing a million people worldwide. Surface finishing is applied not only for corrosion resistance, decorative appearance and hardness, but it also changes properties - mechanical, thermal, optical, electrical, magnetic, surface structure, as well as other physical and chemical properties.

The accelerating pace of technological advance in coating and surface finishing - coupled with today's harsh economic realities - makes it critical for every company involved with the use of these technologies to keep fully abreast of the technical developments taking place in corporations, research institutes and universities around the world.

In this presentation I will mainly deal with processes which are less hazardous as well as minimization of waste formation and safe disposal to maintain clean environment in and around the plating shop.

An overview of significant advances in coatings and surface finishing technology developed during the course of 1990 in Europe, N America, Japan and the rest of the developed world are given below:

- *Black Chromium*
- *Zinc alloy plating*
- *Electrophoretic Lacquer*
- *Nickel-free gold plating system*
- *Electroles Nickel*
- *EMI/RFI shielding*
- *Non-hazardous plating processes*
- *DPS for PCB*
- *Precious Metal Plating*

NEW GENERATION BLACK CHROMIUM

Electrodeposited Black Chromium is now being used on an increasing commerical scale for the production of an alternative to bright chromium on articles such as builders hardware, door fittings, office furniture, cycle and motorcycle components, umbrella tubes, pens, watch cases and straps, spectacle frames etc.

It has wide applications as a non glare finish for automobile interior fittings and

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body trim, optical instruments such as cameras, binoculars etc. By using a combination of bright and black chromium plated components, an attractive two tone effect can be obtained. Black chrome has established itself as the favoured selective coating for most solar absorbers as it has excellent optical properties and durability.

The black chrome deposit is hard and resistant to wear, heat and corrosive environments and hence black chromium is preferred to other black finishes obtained from processes such as black nickel, copper oxide, black anodised aluminium and even paint and porcelain enamel, as well as a host of other processes.

The growing market for this functional coating is serving as a new growth area for the electroplating industry. This is particularly important in view of the non-growth forecasts of plating for decorative purposes

Process

Most of the compositions used for electroplating Balck Chrome are based on chromic acid catalyst. Catalyst composition varies considerably. Some composition of catalyst contain silico-fluoride and selenium dioxide; others contain acetate and modifiers. The latest catalysts in use are quite different from conventional catalysts. These catalysts help in obtaining better optical properties, durability and exceptionally high covering and throwing power.

ELECTROPHORETIC LACQUER

Electrophoretic Lacquer consists of water based Acrylic/Polyurathane resin lacquer which protects plated metal surfaces and solid brass. The electrodeposited finish resists tarnish and corrosion and improves wear proeprties.

The process is endowed with high throwing power. Clear Lacquer after curing at temperature of 140 to 180°C has excellent gloss and image clarity. It has excellent U.V. exposure stability, hardness upto 4H and it is resistant to alchohol rub. It has a reliable performance and used worldwide by quality platers.

Applications

- Lamp & Light fittings
- Trophies
- Wire goods
- Gift items
- Plumbing fixtures
- Picture frames
- Locks and clasps for luggage
- Metal furniture and a broad range of related products
- Spectacle frames
- Presentation articles

A wide range of colours can also be obtained by using one of the folowing techniques:

(1) In Tank Dyeing: Dye material added to the clearlyte Lacquer Tank

(2) Post Plating Dyeing; Colouring after lacquering by immersion in a separate dye solution.

These lacquer coatings - both the clear and the coloured ones - find widespread

applications for decorative and aesthetic purposes: for example for protection of silver, gold, brass, bronze or black nickel for items like costume jewellery, taps stationary, giftware, furniture and hardware. The coloured lacquer coatings are used on many above listed items.

The essential equipment for this specially formulated and designed process consists of tanks, rectifiers, ultrafiltration unit and curing ovens.

Features/Benefits:

- Clear resin topcoat to protect brass and plated metal surfaces.
- Upto 90% reduction of VOCs; No fire hazard
- Excellent film clarity; No teardropping or rainbowing
- Cathodic deposition eliminates substrates attack
- 4H Pencil hardness and UV stability for improved appearance
- Easy to control; Wide operating window
- Eliminates manual racking and unracking; easily automated
- Uniform coating thickness when finishing complex shapes

BOLD ZINC IRON PROCESS

A black, highly corrosion resistant finish, is becoming increasingly in demand. The combination of the low concentration zinc iron bath with a silver free black chromate gives platers a viable alternative to electrophoretic paint, powder coating and other zinc plating systems.
Electrodeposition of zinc iron alloys from ZINCROLYTE NCZ Fe takes place from alkaline non-cyanide solutions. The deposited alloy typically contains 0.3-0.7% iron. The process is suitable for rack and barrel plating and the equipment needed is similar to that required for alkaline cyanide-free zinc plating.

The solution contains a low concentration of zinc metal (typically 7.5 g/l), sodium hydroxide, a complexing agent, 50 mg/l iron and additives to produce cohernt unfirmly bright and ductile deposits.

Anode System

The most reliable and efficient production is achieved by the use of a separate zinc replenishment tank. In the plating tank, mild steel anodes are used. The zinc replenishment tank contains zinc balls or slabs which dissolve chemically in the plating solution and is connected to the plating tank via a pump and filter. .

The advantages of this system are:

- No roughness due to detached anode particles
- Anodes are left in solution during idle periods
- Constant anode gemetry
- Easy to control zinc concentrations in the bath

ZINC ALLOY PLATING

Over the years zinc plating has become firmly established as a very cost effective

method of obtaining good corrosion protection. However, standards of required performance are rising, especially led by the automotive industry and this has in turn led to some notable improvements in process technology.

Perhaps the best examples of improved corrosion protection have resulted from the use of zinc alloys, a field pioneered by ENTHONE-OMI with the introduction of zinc cobalt systems many years ago. Zinc nickel and zinc iron are other alloys which have found application, particularly in the automotive industry.

In line with the use of alloys, passivation technology also had to advance. Firstly, to be able to form adherent attractive looking coatings on the alloy surface and secondly to further enhance corrosion protection.

Special passivates have been developed to take full advantage of this type of alloy, including blue, iridescent and black.

Other improvements in zinc plating have focused on the pure zinc baths, where superior plating performance, better passivation and environmental consideration have become increasingly important.

Two significant new developments in zinc plating are described here. One is a new alloy bath based on zinc - iron, called ZINCROLYTE TM NCZ Fe and the other is a pure zinc bath ENTHOBRITE TM CLZ 930, giving excellent performance advantages at elevated temperatures.

The black passivation system is of special interest, since it is silver - free black chromate and gives a most attractive bright black finish with exceptional corrosion resistance - four to six times that of black passivated conventional zinc.

Costs

Calculations show that the zinc - iron alloy process ZINCROLYTE NCZ Fe plus the black silver - free passivation system (UDYFIN TM 7778 and 7795) gives an overall cost reduction of more than 25% when compared with conventional zinc plus black passivate.

WARM CHLORIDE ZINC PROCESS ENTHOBRITE CLZ 930

A significant new trend in acid zinc plating is to obtain higher conductivity and faster plating by operating potassium chloride electrolytes at elevated temperatures. Conventional acid zinc systems are prone to defects when operated at high temperatures, (for example skip plating) and suffer from dullness and high brightner consumption.

Thus a new chemical approach is necessary if the advantages of higher temperature operation are to be achieved. Developed by ENTHONE OMI's R & D group in Europe, ENTHOBRITE TM CLZ 930 has a brightner system which is completely stable up to 45° C and beyond. This can be compared to a practical maximum of 30-32° C for most conventional systems. The basic solution formulation of CLZ 930 is very similar to conventional acid zinc bath and comprises of potassium chloride, zinc

chloride and boric acid.
In general, cyanide baths and alkaline cyanide-free zinc baths have good metal distribution but rather poor efficiency, whereas conventional acid zinc baths have high efficiency but poor metal distribution. Warm acid zinc, with enhanced conductivity, gives high cathode efficiency (95-97%) and excellent metal distribution.

A summary of features and benefits is given below:

- High operating temperature, 35-45° C
- Higher conductivity
- Faster plating rate
- Increased productivity
- Superior metal distribution
- Less time to achieve minimum thickness
- Complex articles can be plated
- No auxiliary anodes needed
- Liquid additive system
- Low foaming, allowing air agitation
- Solution evaporation allows drag-out to be returned to bath
- One shot maintenance brightner
- Bright, ductile deposit
- Post plate forming may be carried out

EMI ELECTROLESS SHIELDING

EMI or "**Electro Magnetic interference**" is created by the operation of any type of electric or electronic computing equipment, from microwave ovens to home computers.

A few years ago, EMI problems were and mainly confined to TV reception interference caused by garage door openers, radio operators or overhead aircraft. Today, EMI-caused problems are increasingly common and much more serious.

EMI from such seemingly innocent sources - as personal computers, childrens' video games and electronic typewriters - has already caused problems with scientific test equipment, police mobile radio communications systems and cardiac pacemakers. EMI emitted from television cameras has even disrupted communications between one of the space shuttles and ground control during the shuttle's final approach for landing.

EMI has beome a problem now because of two reasons:

(i) most electronic housing produced now are made of plastic, not metal. Plastic, of course, is lighter, more versatile and less expensive; But unlike metal, plastic does not shield against EMI.

(ii) use of electronic equipment in the home and workplace has increased tremendously, so has the level of EMI from these devices.

To deal with this problem, the Federal Communications Commission (FCC) implemented Regulation that all electronic computing equipment sold in the U.S.A. (with certain exclusions) must comply with standards for maximum allowable electromagnetic emissions. The FCC regulations have two standards, Class A for industry and class B for the home. Class B is tougher, because homes contain more communications devices affected by EMI, as well as more EMI-causing devices, in a smaller space.

All this has put a lot of pressure on manufacturers to deal with EMI. At the same time, it has created a new discipline called **"electromagnetic compatibility"** that is concerned not only with containing EMI but with protecting computing devices from electrostatic discharge (ED) and shielding these computing devices from externally-produced EMI.

Governmental pressure may also create an "instant industry" filled with a wide range of companies offering an even wider range of solutions.

NICKEL ITCH

Nickel dormentula (Nickel Itch) is an allergic skin reaction to nickel metal that causes severe rash and infection. It is a seriouu problem for many wearers of jewellery, eye - glasses, watch bands etc., becuase the final finish on these items (gold/silver) is usually very thin. If it wears off, the underlayer of nickel becomes exposed to cause problems. Over 20% of Europeans, Japanese & North Americans suffer from nickel itch.

Many European countries have proposed legislations to regulate the use of any item which contains nickel and comes in close contact with the skin. These regulations range from warning lables (Germany) to compelete ban (Sweden). In Japan, an imported jewellery must comply with a proposed directive that restricts production containing nickel and nickel alloys that come in direct and prolonged contact with skin. Although there are currently no similar regulations in North America, they are likely to be proposed in the near feature.

Half of all jewellery, eye - glasses etc., manufactured in North America are for retail sale within the country. The rest is exported to Europe and Japan for sale . This forces many US manufacturers to seek out alternatives to nickel to continue international business operation.

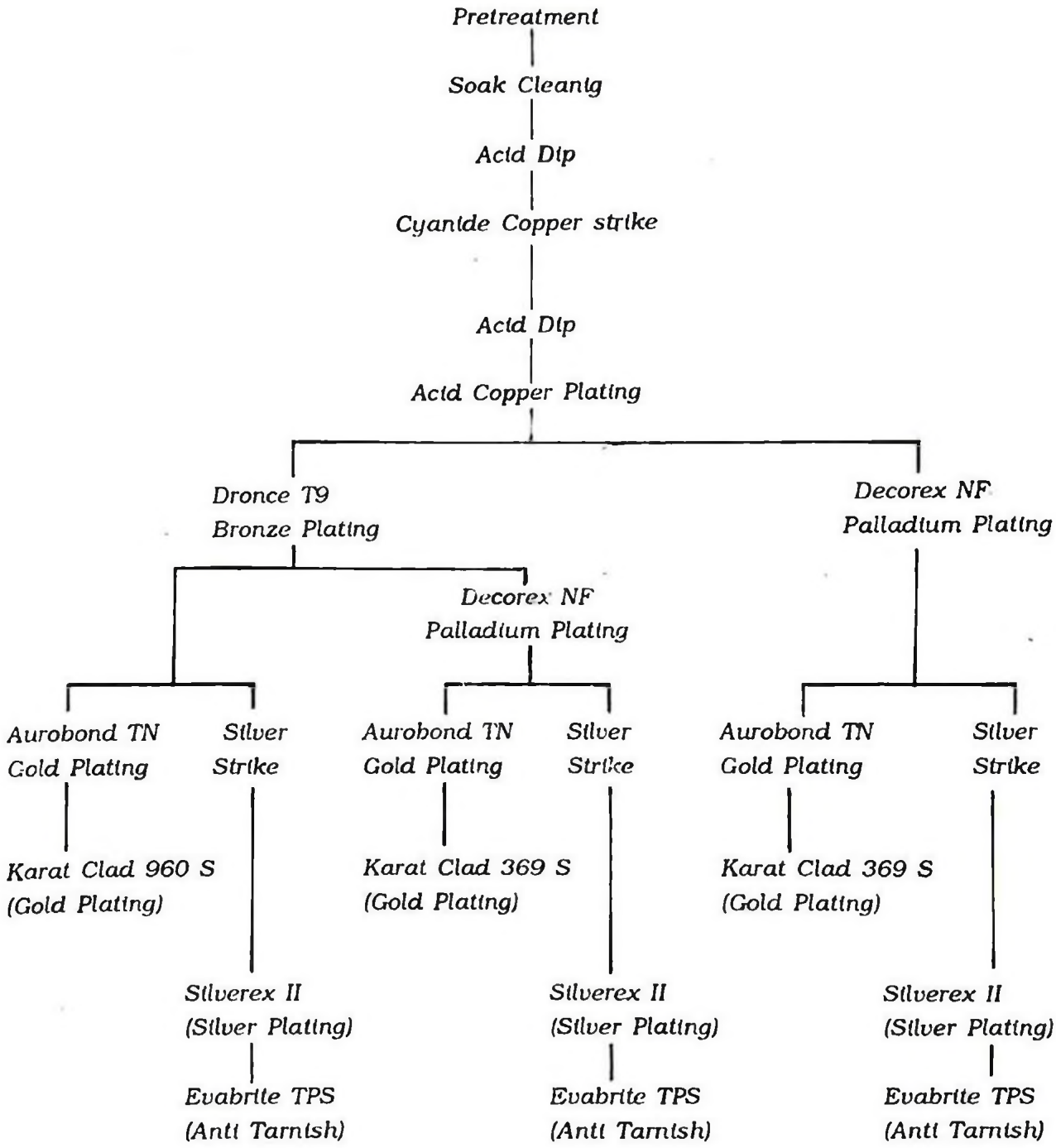
To address this challenge, ENTHONE-OMI has introudced nickel - free plating system; consisting of SEL-REX and UDYLITE processes. Specifically designed to satisfy nickel regulations, these nickel - free processes maintaine highest quality standard. Long time suffers of nickel itch can now wear jewellery again without the side effect.

ENTHONE - OMI nickel - free systems, utilise, bright acid copper to replace, bright nickel electroplate. These is overplated with bronze. BRUNZEX provides a barrier layer and can prevent the migration of gold into copper.

ENTHONE - OMI's nickel - free technology has allowed us to meet increasing global restrictions regarding the presence of nickel in jewellery without sacrificing product quality.

The process is schematically shown here

Process Sequence for nickel Free Gold and Silver Plating



NON HAZARDOUS PLATING PROCESSES

In today's world, environment has rightly become of prime concern for our own well being and for the sake of those who will inherit the earth. To maintain a clean environment, care is needed at different stages of production of metal finishing chemicals-right from manufacture to ultimate usage and of course, disposal of waste from processing and handling to transportation with special attention to safety measures and finally to discarding the refuse, which includes intermediate stages of good packing and the indispensable provisions for safety information to users.

The present practice of waste treatment and disposal in our country, does not in itself, solve the environmental problem created by metal finishing operations. Effluent treatment and disposal involves a huge capital investment, besides a large floor space for the operations. Sometimes the cost of pollution treatment and waste disposal is much more than the cost of the metal finishing process itself. The disposal of sludge poses a serious task. Even the government agencies are finding it very difficult to allocate unobstrusive dumping spaces. Hence, it becomes extremely important to eliminate pollution by reducing and as far as possible, doing away with the use of toxic chemicals.

A change over to non hazardous plating processes is necessary if we are to cooperate with the environmentalists to help in maintaining the environment clean. Of course, there will never be a totally safe and environmental friendly product; only some are more friendly than others. As our knowledge and experience of process chemicals grows and the environment consciousness in our country evolves, so will the attitude of the individual and the industry as a whole change to ensure the use of what we regard as safe products.

Further, it is utmost important that metal recovery systems should be used to recover heavy metals like nickel, copper, zinc, cadmium, silver, gold etc. from effluent discharges. The latest art of pollution control, is the implementation of the zero pollution system achieved by zero discharge of waste waters from cleaners, acids, metals, cyanides, chrome etc. This is an excellent step towards maintaining the environment clean.

However, the most practical approach to tackle the environment problem is to adopt a combination - use processes with non-hazardous chemicals, minimize waste waters, utilize zero discharge technique and recover metals from effluents.