AUTONIC **MX**

Mid-Phosphorus, non-brightened,
Functional, Engineering Coating
ASTM B733 Type IV - V

AUTONIC MX process provides a functional, non-brightened, mid-phosphorus (7-11 %P) electroless nickel deposit. The process designed for high production processing in engineering applications. The AUTONIC MX process represents extensive research and development in electroless nickel technology, combining industry requirements and unique advanced chemistry.

FEATURES

AUTONIC MX is a mid-phosphorus producing, electroless nickel process using advance organo-metallic stabilizers to produce an exceptionally low stress, corrosion resistant and uniform deposit. The plating rate for the AUTONIC MX is 0.6 to 0.9 mil/hour.

AUTONIC MX 1 Mil Deposits have been tested in Neutral Salt Spray in accordance to ASTM B117 for over 1000 hours with no red rust or substrate corrosion.

AUTONIC MX Deposit provides wear and corrosion resistance to metal parts in a wide range of environments. Typical hardness values are 470-520 Knoop at 100 g load (KHN100) in the as plated condition and 885-980 (KHN100) in the heat-treated condition of Mil-C-26074D, Class 2.

AUTONIC MX process is designed for high production operations with simplicity and ease of operations. Replenishment of the process involves the use of two chemicals, AUTONIC MXPC and AUTONIC LNS, Liquid Nickel Sulfate. The products are liquid and can be added to the process while plating. These additions will maintain all the constituents and pH of the process providing for 10 plus metal turnovers of processing.

AUTONIC MX process is designed for simple operation. Within the AUTONIC are all the necessary chemicals to maintain the plating process and produce a high performance deposit.

AUTONIC MX process is stable and is capable of passing a 120 second palladium stability test. Typical electroless nickel solutions will only pass 5 to 10 seconds.

AUTONIC MX process has been formulated for ease in waste treatment providing a process that can be plated down to less than 1 ppm.

DEPOSIT PROPERTIES AUTONIC MX DEPOSIT

Electroless Nickel Deposits can be classified into several types based on the phosphorus alloy. The MX process produces an ASTM B733 Type IV deposit. These deposits are suited for a wide range of applications requiring wear and corrosion protection. A unique advantage of the MX process is the lack of heavy metals like cadmium and others in the formulation that produce adverse effects on deposits with thicknesses greater than 2.5 mils (60u).

PHYSICAL:

Bond Strength to Steel	90,000 PSI - 620 MPa
Bond Strength to Aluminum	45,000 PSI - 310 MPa
Elongation	0.2 to 0.4 %
Tensile Strength	40 - 60 KSI
Internal Stress	1.2 KSI Tensile as plated
Thermal Coefficient of Expansion	1.2 to 1.4 X 10^-5
Melting Point	881 (C)
Electrical Resistivity	55 - 90 X 10^-6 ohm-cm

COMPOSITION:

Nickel	Balance
Phosphorus	7.0% to 11.0%
Trace	0.15 or less

HARDNESS:

470 - 520 KHN,100g As Plated
885 - 980 KHN,100g Heat treated 700 (F) for 1 hour

STRUCTURE

In the as plated condition the deposit is amorphous. Upon heating to 220 (C) the deposit will start to crystallize and NiP^3 will form. The amount and orientation of the nickel will control the physical properties of the deposit.

CORROSION RESISTANCE

The AUTONIC MX deposit has excellent corrosion resistant:

Environments	Electrochemical	Immersion
Water, Brine 3.5% NaCl & Sat. CO2	9.8 mpy	5 mpy
Water, Brine 3.5% NaCl & Sat H2S	0.02 mpy	nil
Water, Sea 3.5%	0.08 mpy	nil

Porosity

Ferroxyl on polished steel panels with 1 mil Passes with no blue spots
ASTM B117 Neutral Salt on polished steel panels with 1 mil Passes 1000 hours

WEAR RESISTANCE

AUTONIC MX deposits are hard and resistant to abrasion and adhesive wear applications. Typical wear rates for the coating are 12 to 16 mg/1000 cycles Taber Abrader for the as plated condition and 6 - 12 gm/1000 cycles for the precipitate hardened deposits

OPERATING THE AUTONIC MX PROCESS

The AUTONIC MX Process is designed for ease of operations and process control. To operate the process the plater must be able to check the nickel concentration and pH and make adjustments in the form of replenishment concentrates provided by Stapleton. These chemicals are added to the working process as required.

The plating process is operated in a specially designed process tank made of poly-pro or SS316. This tank heats the solution to 89 C (192 F) and filters it through a 1 to 5 micron bag at 10 to 20 times the volume of the tank each hour.

To maintain an efficient operation, the solution should be heated with a low density heat source and parts should be loaded when the operating temperature is reached. When all the parts are processed for the day the heat should be reduced to below 50 C (122 F) with the filter operating and air agitation off.

The AUTONIC Series processes use AUTONIC LNS, carbon treated and submicron filtered, pure Liquid Nickel Sulfate to insure optimum process performance and quality deposits.

While the process is operating, the parts will consume nickel ions and reducing agent, thereby requiring their replacement to maintain the plating reaction. The amount of nickel consumed is generally measured in metal turnovers where 1 cycle is equal to a 100% replacement of the nickel metal in the original solution. The amount of reducing agent used is dependent on the amount of nickel consumed and will be replaced when the addition of AUTONIC MXPC is made.

TABLE 1, AUTONIC MX MAKE-UP FORMULA

		Tank Volume, Gallons					
Product	conc.	100	150	200	250	300	500
AUTONIC MXPA	100 ml/l	10	15	20	25	30	50
AUTONIC LNS (5#/gal)	50 ml/l	5	7.5	10	12.5	15	25

PROCEDURES FOR MAKING UP A NEW AUTONIC MX SOLUTION:

1. Fill approximately 2/3 of the final working volume of cold deionized water into a clean plating tank.
2. Add the AUTONIC MXPA to the plating tank.
3. Fill the tank to 95% percent volume with Deionized water.
4. Add the AUTONIC LNS and mix.
5. Record the new solution in a process log.
6. Start using your New AUTONIC Solution

TABLE 2, SUMMARY of OPERATING CONDITIONS

Conditions Analysis	at make-up	UCL	LCL	Control Point	Frequency
Nickel Metal	6.6 g/l	6.6 g/l	3.5 g/l	5.8 g/l	.5 - 4 hr.
Hypophosphite	24 g/l	35 g/l	15 g/l	28 g/l	4 - 8 hr.
pH(Electrometric)	4.6	4.9	4.0	4.6	0.5 - 2 hr.
Temperature	91 C - 195 F	95 C - 203 F	89 C - 192 F	91 C - 195 F	0.5 - 2 hr.

PROCESS CONDITIONS and OPERATIONS

The AUTONIC MX process is simple to operate. A list of operating conditions can be found in TABLE 2. The major control is provided by checking for nickel using an EDTA Titration and from the results computing an addition of AUTONIC replenisher concentrates. These additions will maintain the chemistry, adding all the necessary chemicals to sustain the reaction. This procedure is required every time the solution uses 10% to 20% of the available nickel metal.

The Temperature and pH are also important in sustaining the reaction and therefore should also be controlled. The temperature causes the reaction to proceed and ultimately controls the thickness of the plating. While the pH effects the alloy and plating rate and will also effect the thickness of the plating.

In TABLE 2 the Upper Control Limit (UCL), Lower Control Limit (LCL), Control Point and recommended frequency of analysis are given. By adhering to these control points you will be able to produce consistent quality and high performance at the lowest possible cost.

TABLE 3, ADDITION SCHEDULE for AUTONIC MX Process

Nickel concentration g/l								
5 ml sample	6.6	6.2	5.8	5.4	5.0	4.6	4.2	3.8
0.057M EDTA Na2	100%	93%	88%	81%	75%	69%	63%	57%
mls to endpoint	10	9.3	8.8	8.1	7.5	6.9	6.3	5.7
Volume of Tank								
100 Gallons								
AUTONIC MXPC	0	0.70	1.2	1.90	2.50	3.10	3.10	3.10
AUTONIC LNS (5#/gal)	0	0.35	0.6	0.85	1.25	1.55	1.55	1.55
250 Gallons								
AUTONIC MXPC	0	1.75	3.00	4.75	6.25	7.75	7.75	7.75
AUTONIC LNS (5#/gal)	0	0.875	1.50	2.385	3.125	3.875	3.875	3.875

GETTING THE MOST OUT OF YOUR AUTONIC MX PROCESS

1. The solution operates most efficiently when it is plating with a load of between 30 to 90 square inches per gallon with mechanical agitation. Air agitation will act as a stabilizer and slow the plating rate slightly.

2. Possible contaminates from the shop or parts should be controlled as much as possible. These contaminates can be in the form of organics, metals, or solid materials. They can be airborne, on the part, or waterborne. A clean shop with processes that are maintained correctly will help insure excellent operations and maximum performance of the deposit with minimum costs of operations.

3. The AUTONIC Process will produce the most consistent deposits when it is operated in the 80% to 90% activity range. To operate in this range it is advisable to have the person who is plating titrate and make the additions. This is because the 10% window of operation may only last for 20 to 30 minutes, requiring a second person to be dedicated to the titration and additions to the process.

4. The AUTONIC Process is designed to be operated with continuous filtration through a 5 micron bag. It is advisable for the pump filter system be sized to move 20 times the volume of the solution in one hour. This high filtration will remove any unwanted particles which may be in the process and insure that as the solution ages and at boiling the pump will still be providing in excess of 10 turnovers per hour.

5. When the process reaches about 700% or after 7 times the original nickel metal has been added; it is time to think about plating the solution down to 50% and making up a new solution. With this type of approach you will be able to operate at the most economical point, using nearly 95% of all the nickel and minimizing your hazardous waste. By processing until exhaustion the solution will have generally higher than 100% nickel and the overall efficiency could be less than 90%

6. The AUTONIC MX Process can be loaded with parts up to 140 square inches per gallon. Working the solutions hard (60 to 90 in2/gal) after the first day of operation will provide the most efficient operations for both chemicals and facility. Low loading (5 to 20 in2/gal) will have the effect of reducing the efficiency of the process and require additional replenisher to sustain the plating rate due to oxidation of hypophosphite.

ORDERING PRODUCT

The following Products are used to operate this process:

Process	Description	55 gal	5 gal
AUTONIC MXPA	Make-Up Concentrate	MXPA3-	MXPA3-
AUTONIC MXPC	Replenisher Reducer Salts	MXPC3-	MXPC2-
AUTONIC LNS	Liquid Nickel Sulfate	LNS-3-	LNS-2-

DAILY CARE

1. Cover the tank when you are not loading or unloading the tank.

2. Strip the tank with 20% to 30% nitric acid at the end of the production run if any significant nickel has plated onto the sides or bottom. This will help eliminate roughness and the significant loss of chemicals. After stripping the tank and piping you should always rinse and neutralize the system of nitric with a dilute solution of ammonium hydroxide. If nitric acid is present in the solution a dull or streak deposit may develop.

3. Turn off the heat when the solution is not going to be used for several hours. Prolonged heating with air agitation and no work in the tank will cause a slight oxidation of the reducing agents and subsequently reduce the efficiency of the process.

4. Always check the pH when you test for nickel. The results should be noted in a log and any correction required should be made using dilute sulfuric acid or ammonium hydroxide.

GENERAL EQUIPMENT INFORMATION

Filtration - Continuous filtration through 5 to 15 micron poly-propylene filter bag which is elevated above the solution is recommended. This produces a pressure differential to cause filtration and removes the high concentration of heat from the filter area. With the bag elevated, any plateout or activity in the solution can be detected and corrective action taken before a problem is evident.

Tank and Materials of Construction - All tanks, piping, racks and carriers which come in contact with the solution should be made of CPVC, Poly-propylene, 316LC Stainless Steel, or Kynar. The electroless nickel solution and stripping solutions are corrosive and care should be taken to prevent contact with electrical and mechanical systems.

Agitation - Mechanical agitation is recommended when the process is operating. A minimal loss of about 5% per day of reducing agent will occur when using air agitation. This loss can be minimized by not operating the air agitation and heaters when the tank is free of work. Prolonged heating and air will accelerate the oxidation of sodium hypophosphite.

Ventilation - The vapor from AUTONIC MX plating process is inherently corrosive due to the high concentration of salts in the material. All ventilation equipment should be constructed with polypropylene, PVC or fiberglass to insure good equipment life and a healthy area for the platers.

Stapleton Technologies Inc.
1350 W 12th Street Long Beach, CA
(800) 266-0541 (562) 437-0541

Rev 3.4 7/97

NON-WARRANTY