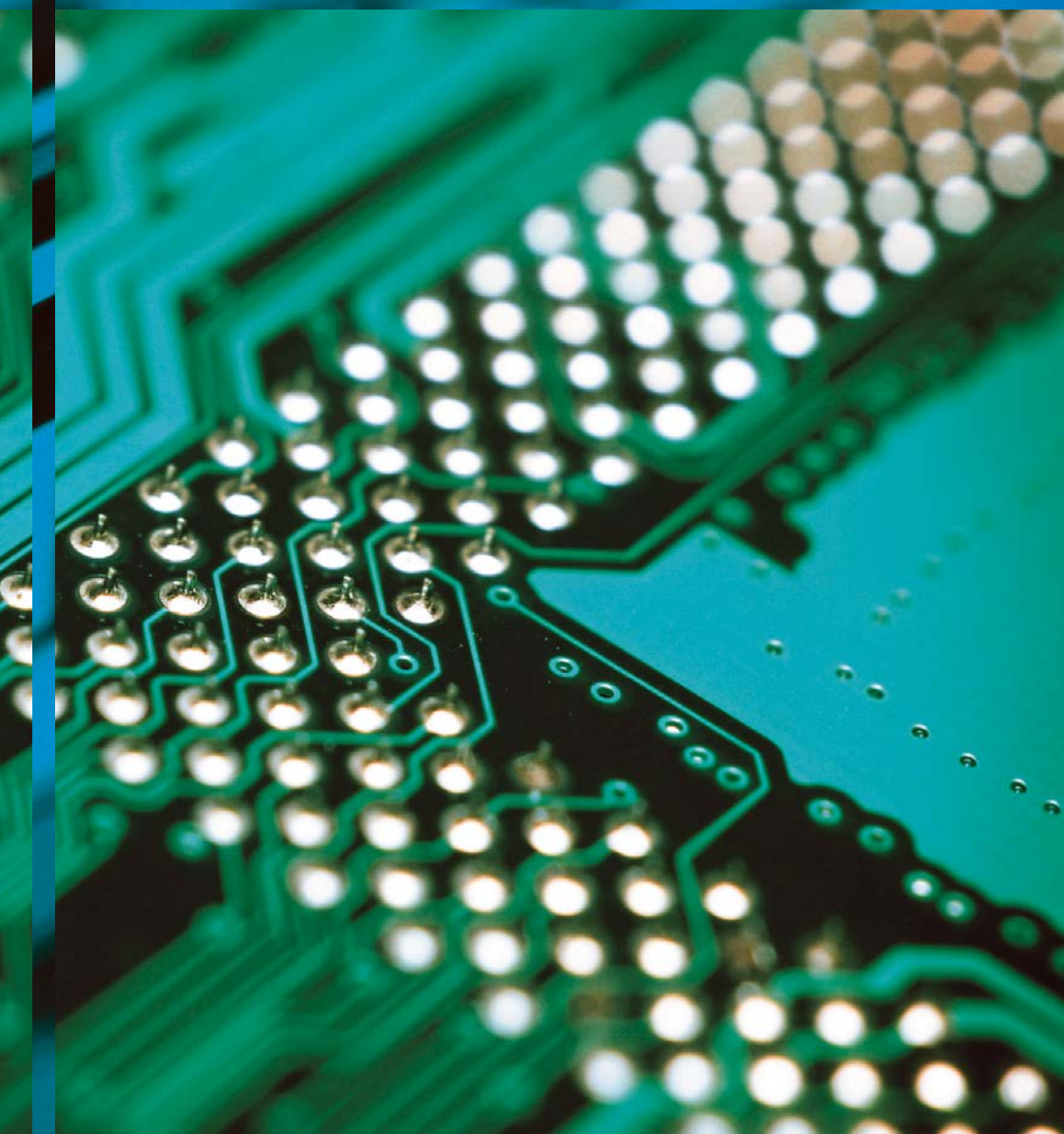
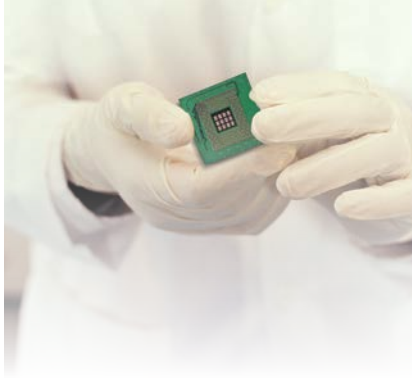


Plating on Plastics and Metal Finishing Technologies





Plating on Plastics and Metal Finishing Technologies

Linking Innovation to Performance

Plating on Plastics and Metal Finishing Technologies delivers integrated materials and surface finishing processes for use in electronics, optoelectronics and industrial applications worldwide. Our processes provide essential functionality to the end-use markets we serve, including reliable interconnects for electronic packaging, EMI shielding of electronic devices, cost-effective optoelectronic components, corrosion resistance of industrial articles, and decorative treatments for metal and plastic surfaces. By investing in innovative technologies, leveraging global operations and providing outstanding service, we link innovation to performance every day around the world.

Table of Contents

Plating on Plastics–Decorative	1
Plating on Plastics–Functional.....	2
Passive Components.....	3
Metal Finishing.....	3
Wire Plating	4
Lead Frame Plating.....	5
Barrel/Vibratory–Electronics	6
Reel to Reel	8
Conversion Tables.	10
Atomic Weights.	12
Metal Content of Plating Salts.....	16
Concentrations of Common Acids and Bases.....	18
Hull Cell Scale	19



Plating on Plastics–Decorative

Process	Process Name	Description
Pre-etch	Cleaner PM-900 Conditioner PM-920 Conditioner PM-921	<ul style="list-style-type: none"> Removes soils and aids in wetting of plastic surfaces Conditioner for ABS plastic Conditioner for ABS/PC and other thermoplastics
Chrome Etch	Etch Additive PM-941-A-2	<ul style="list-style-type: none"> Etch wetter
Neutralizer	Neutralizer PM-954	<ul style="list-style-type: none"> Chrome neutralizer
Catalyst	CATAPOSIT™ PM-957 CATAPOSIT™ PM-959 Catalyst	<ul style="list-style-type: none"> Standard Pd activator, colloidal
Accelerator	Accelerator PM-964 Accelerator PM-960	<ul style="list-style-type: none"> Salt-based accelerator, preferred for high volume applications Liquid accelerator
Electroless	NIPOSIT™ PM-980 NIPOSIT™ PM-988 CIRCUPOSIT™ Electroless Copper	<ul style="list-style-type: none"> Low-temperature EN, low thickness, metallization for POP Ammonia-, Pb-, Cd-free, low-temperature EN for POP EDTA-based electroless copper for POP
Semi-bright Nickel	NICKEL GLEAM™ SB 200	<ul style="list-style-type: none"> Undercoat for duplex nickel, high levelling and ductility
Bright Nickel	NICKEL GLEAM™ BR 220	<ul style="list-style-type: none"> Bright nickel, exceptional brightness and levelling
Chrome Plate	CHROME GLEAM™ 3C CHROME GLEAM™ 3C Jet	<ul style="list-style-type: none"> Trivalent chromium plating process Black trivalent chromium plating process

Plating on Plastics–Functional

Process	Process Name	Description
Etch	Conditioner PM-925 CIRCUPOSIT™ MLB Promoter 3308	<ul style="list-style-type: none"> Alkaline conditioner/etch for liquid crystal polymers (LCP) Permanganate etch, used after PM-925 for polyetherimides (ULTEM)
Neutralizer	CIRCUPOSIT™ Neutralizer 3313 CIRCUPOSIT™ Neutralizer PM-954	<ul style="list-style-type: none"> Acidic neutralizer permanganate and PM-925 Chrome neutralizer
Promoter	Cleaner-Conditioner 231	<ul style="list-style-type: none"> Alkaline catalyst promoter
Catalyst	CATAPOSIT™ PM-957 CATAPOSIT™ PM-959	<ul style="list-style-type: none"> Standard Pd activator, colloidal
Accelerator	Accelerator PM-960 Accelerator PM-964	<ul style="list-style-type: none"> Liquid accelerator Salt-based accelerator, preferred for high-volume applications
Electroless Copper	CIRCUPOSIT™ 71 CIRCUPOSIT™ Electroless Copper	<ul style="list-style-type: none"> Full-build electroless copper Uniform, bright electroless copper
Activator	Activator 472	<ul style="list-style-type: none"> Ionic palladium activator, activation of copper for electroless nickel
Electroless Nickel	DURAPOSIT™ MF 1110	<ul style="list-style-type: none"> Ammonia-, lead- and cadmium-free electroless nickel

Passive Components

Process	Process Name	Description
Nickel Plate	NIKAL™ PC-3 NIKAL™ MP-200	<ul style="list-style-type: none"> Semi bright finish Matte finish
Tin Plate	SOLDERON™ SG-J	<ul style="list-style-type: none"> Sulfonic acid-based for pH sensitive devices. Excellent wetting speeds
Tin/Solder Plate	SOLDERON™ LG	<ul style="list-style-type: none"> MSA pure tin or lead alloy process for pH sensitive devices
Post-treatment	NEUTRA RINSE™ 80 CERMETEC™ NO TARN™ Sn2	<ul style="list-style-type: none"> Neutralizes acid film Rinse aid Tin anti-tarnish

Metal Finishing

Process	Process Name	Description
Tin/Solder Plate	SOLDERON™ RONASTAN™ EC TINGLO CULMO™	<ul style="list-style-type: none"> Matte tin, tin/lead, MSA Matte tin, sulfate-based Bright tin, sulfate-based
Silver Plate	SILVER GLO™ 3K SILVER GLO™ 3K BP SILVERON™ GT-101	<ul style="list-style-type: none"> Cyanide silver, electronic applications Cyanide-based, bright decorative Bright or semi-bright, non cyanide silver
Cadmium	KADIZID™	<ul style="list-style-type: none"> Acid-based cadmium
Post-treatment	NO TARN™ Sn2 Anti-Tarnish 7130 CERMETEC™	<ul style="list-style-type: none"> Tin anti-tarnish Copper anti-tarnish Rinse aid

Wire Plating

Process	Process Name	Description
Cleaner	RONACLEAN™ E950 LF	<ul style="list-style-type: none"> • Low foaming
Activator	10–20% SOLDERON™ Acid HC	
Tin/Solder Plate	SOLDERON™ MHS-W SOLDERON™ BTB	<ul style="list-style-type: none"> • Matte, tin, tin/lead alloy, MSA • Bright, tin, tin/lead, MSA
Auxiliary Products	SOLDER STRIP™ 8T LRSE 557 Support Electrolyte SOLDERON™ SD Antifoam SOLDERON™ RD Concentrate	<ul style="list-style-type: none"> • Non-nitric-based tin/solder stripper • Support electrolyte for the CVS • Antifoam • Antioxidant

Lead Frame Plating

Process	Process Name	Description
Cleaner	RONACLEAN™ GP300-LF RONACLEAN™ NP 200	<ul style="list-style-type: none"> All purpose cleaner All purpose, low COD cleaner
Activator/Descaler	ACTRONAL™ 660	<ul style="list-style-type: none"> Copper descaler
Copper Plate	COPPER GLEAM™ RG-11	<ul style="list-style-type: none"> Bright acid copper
Nickel Plate	NIKAL™ PC-3 NIKAL™ MP 200	<ul style="list-style-type: none"> Semi bright finish Matte finish
Tin/Solder Plate	SOLDERON™ SC SOLDERON™ ST-380	<ul style="list-style-type: none"> Matte, tin/lead alloy, MSA Whisker mitigated pure tin
Palladium	PALLADURE™ 200	<ul style="list-style-type: none"> Chloride-based, pure palladium
Post-treatment	CERMETEC™ NO TARN™ Sn2 Anti-Tarnish 7130	<ul style="list-style-type: none"> Rinse Aid Tin anti-tarnish Copper anti-tarnish
Auxiliary Products	SOLDER STRIP™ 8T LRSE 557 Support Electrolyte SOLDERON™ SD Antifoam SOLDERON™ RD Concentrate	<ul style="list-style-type: none"> Non-nitric-based tin/solder stripper Support electrolyte for the CVS Antifoam Antioxidant, used in all SOLDERON™ processes except the ST-380

Barrel/Vibratory–Electronics

Process	Process Name	Description
Cleaner	RONACLEAN™ NP 200	<ul style="list-style-type: none"> All purpose, low COD cleaner
	RONACLEAN™ E 950 LF	<ul style="list-style-type: none"> All purpose cleaner
Activator/Descaler	ACTRONAL™ 660	<ul style="list-style-type: none"> Copper descaler
	PREPOSIT™ Etch 748	<ul style="list-style-type: none"> Copper descaler
Copper Plate	COPPER GLEAM™ RG-11	<ul style="list-style-type: none"> Bright acid copper
Nickel Plate	NIKAL™ PC-3	<ul style="list-style-type: none"> Semi bright finish
	NIKAL™ MP-200	<ul style="list-style-type: none"> Matte finish
Nickel Activator	RONATAB™ Acid Activator PC-1	<ul style="list-style-type: none"> Nickel activator
Palladium	PALLADURE™ 200	<ul style="list-style-type: none"> Chloride-based, pure palladium
Gold Strike	AURALL™ 364-A	<ul style="list-style-type: none"> Pure gold strike
	RONOVEL™/AUROSPEED™ Strike	<ul style="list-style-type: none"> Hard gold strike
	RONOVEL™ CM	<ul style="list-style-type: none"> Cobalt-hardened, oxalate-free, acid gold, contains range extender for improved thickness distribution
	RONOVEL™ N	<ul style="list-style-type: none"> Nickel-hardened, acid gold, contains range extender for improved thickness distribution
	AURONAL™ BGA	<ul style="list-style-type: none"> Pure gold, lead-based brightener
	AURALL™ 305 & 305 M	<ul style="list-style-type: none"> Pure gold, arsenic brightener

Barrel/Vibratory–Electronics

Process	Process Name	Description
Tin/Solder Plate	SOLDERON™ PC RONASTAN™ EC TINGLO CULMO™ SOLDERON™ ST-200	<ul style="list-style-type: none"> • Matte, tin/lead alloy, MSA • Matte, pure tin, sulfate-based • Bright, pure tin, sulfate-based • Matte, pure tin whisker resistant, over nickel, MSA
Silver Plate	SILVER GLO™ 3K SILVERON™ GT-101	<ul style="list-style-type: none"> • Semi bright silver • Bright, non cyanide silver
Post-treatment	NO TARN™ Sn2 NEUTRA RINSE™ 80 CERMETEC™ Anti-Tarnish 7130	<ul style="list-style-type: none"> • Tin anti-tarnish • Neutralizes acid film, from tin plating • Rinse aid • Copper anti-tarnish
Auxiliary Products	SOLDER STRIP™ 8T LRSE 557 Support Electrolyte SOLDERON™ SD Antifoam SOLDERON™ RD Concentrate SOLDERON™ AO-52 SUPER STRIP 300	<ul style="list-style-type: none"> • Non-nitric-based tin/solder stripper • Support electrolyte for the CVS • Antifoam • Antioxidant, used in all SOLDERON™ processes except the ST-380 • Alternate antioxidant, used in the SOLDERON™ ST-200 process • Gold stripper

Reel to Reel

Process	Process Name	Process Description
Cleaner	RONACLEAN™ E950 LF RONACLEAN™ NP 200	<ul style="list-style-type: none"> All-purpose cleaner All-purpose, low COD cleaner
Activator/Descaler	ACTRONAL™ 660 PREPOSIT™ 748 Etch	<ul style="list-style-type: none"> Copper descaler Potassium mono persulfate
Copper Plate	COPPER GLEAM™ RG-11	<ul style="list-style-type: none"> Bright, high speed acid copper
Nickel Plate	NIKAL™ PC-3 NIKAL™ MP-200	<ul style="list-style-type: none"> Semi bright finish Matte finish
Activator	RONATAB™ PC-1	<ul style="list-style-type: none"> Nickel activator
Gold Strike	AURALL™ 364 -A RONOVEL™ Strike AUROSPEED™ Strike	<ul style="list-style-type: none"> Pure gold strike Hard gold strike Hard gold strike – no range extender
Gold	RONOVEL™ CM RONOVEL™ N AURONAL™ BGA	<ul style="list-style-type: none"> Cobalt-hardened, oxalate-free, acid gold, contains range extender for improved plating distribution Nickel-hardened, acid gold, contains range extender for improved plating distribution Pure gold, non oxidizing, lead-based brightener

Reel to Reel

Process	Process Name	Description
Palladium	PALLADURE™ 200	<ul style="list-style-type: none"> Chloride-based, pure palladium
	PALLAMET™ 500	<ul style="list-style-type: none"> Sulfate-based, palladium/nickel
	PALLAMET™ 600	<ul style="list-style-type: none"> Low ammonia sulfate-based palladium/nickel
Silver	SILVERON™ GT 101	<ul style="list-style-type: none"> Non cyanide bright and semi-bright
	SILVER GLO™ 3K	<ul style="list-style-type: none"> Semi-bright cyanide based
Tin/Solder Plate	SOLDERON™ SC	<ul style="list-style-type: none"> Matte, tin/lead alloy, MSA
	SOLDERON™ ST-200	<ul style="list-style-type: none"> Matte, pure tin whisker resistant, over nickel, MSA
	SOLDERON™ BHT 350	<ul style="list-style-type: none"> Bright whisker mitigated
	SOLDERON™ BHT-90	<ul style="list-style-type: none"> Bright 90/10, MSA
	SOLDERON™ BT100	<ul style="list-style-type: none"> Bright tin MSA
Post-treatment	NEUTRA RINSE™ 80	<ul style="list-style-type: none"> Neutralizes acid film, from tin plate
	CERMETEC™	<ul style="list-style-type: none"> Rinse aid
Auxiliary Products	SOLDER STRIP™ 8T	<ul style="list-style-type: none"> Non-nitric-based tin/solder stripper
	LRSE 557 Support Electrolyte	<ul style="list-style-type: none"> Support electrolyte for the CVS
	SOLDERON™ SD Antifoam	<ul style="list-style-type: none"> Antifoam
	SOLDERON™ RD Concentrate	<ul style="list-style-type: none"> Antioxidant, used in all SOLDERON™ processes except the ST-380
	SOLDERON™ AO-52	<ul style="list-style-type: none"> Alternate antioxidant, used in the SOLDERON™ ST-200 process
	SUPER STRIP 300	<ul style="list-style-type: none"> Gold stripper

Conversion Tables

To convert from a unit in the column at the left to a related unit, multiply by the factor in the appropriate right hand column. For example, to convert inches to meters multiply by 0.0254.

Length

Units	Centimeters	Meters	Kilometers	Inches	Feet
Centimeters	1	0.01	0.00001	0.3937	0.03281
Meters	100	1	0.001	39.37	3.281
Kilometers	100,000	1000	1	39400	3281
Inches	2.54	0.0254	2.54×10^{-5}	1	0.08333
Feet	30.48	0.3048	0.000305	12	1

1 angstrom = 1×10^{-4} microns = 1×10^{-8} cm = 3.937×10^{-9} inches
 1 mile = 1.609 km = 1760 yd = 1.151 nautical mile
 1 meter = 1.094 yd

Mass & Weight

Units	Grams	Kilograms	Grain (Avoir.)	Ounce (Avoir.)	Lb. (Avoir.)
Gram	1	0.001	15.43	0.03527	0.0022
Kilogram	1000	1	15432	35.27	2.205
Grain (Avoir.)	0.06480	6.48×10^{-5}	1	0.00229	0.000143
Ounce (Avoir.)	28.35	0.02835	437.5	1	0.0625
Lb. (Avoir.)	453.6	0.4536	7000	16	1

Volume & Capacity

Units	Cubic CM	Liters	Cubic Inches	Fluid Ounces (U.S.)	Gallon (U.S.)
Cubic cm	1	0.001	0.06102	0.03381	0.000264
Liter	1000	1	61.02	33.81	0.2642
Cubic inches	16.39	0.01639	1	0.5541	0.00433
Cubic ft.	28300	28.32	1728	957.5	7.481
Cubic yd.	765000	764.5	46700	25900	202.0
Fl. oz. (U.S.)	29.57	0.02957	1.805	1	0.00781
Fl. pt. (U.S.)	473.2	0.4732	28.88	16	0.1250
Fl. quart (U.S.)	946.4	0.9464	57.75	32	0.25
Gallon (U.S.)	3785	3.785	231.0	128	1

1 gal. (Imperial) = 1.20094 gal. (U.S.)

Density

Units	Sq. Cm	Sq. Meters	Sq. Inches	Sq. Ft.
Sq. centimeters	1	0.0001	0.1550	0.00108
Sq. meters	10000	1	1550	10.76
Sq. inches	6.452	0.000645	1	0.00694
Sq. ft.	929	0.0929	144	1

1 cubic ft. water at 60°F = 62.37 lb. 1 gram/cu cm = 62.37 lb./cu ft.

1 gal. Water at 62°F = 8.337 lb. 1 lb./cu ft. = 0.1337 lb./gal.

Atomic Weights

Name	Symbol	Atomic Number	Atomic Weight
Actinium	Ac	89	(227)
Aluminum	Al	13	26.9815
Americium	Am	95	(243)
Antimony	Sb	51	121.75
Argon	Ar	18	39.948
Arsenic	As	33	74.9216
Astatine	At	85	(210)
Barium	Ba	56	137.34
Berkelium	Bk	97	(247)
Beryllium	Be	4	9.0122
Bismuth	Bi	83	208.980
Boron	B	5	10.811
Bromine	Br	35	79.909
Cadmium	Cd	48	112.40
Calcium	Ca	20	40.08
Californium	Cf	98	(251)
Carbon	C	6	12.0111
Cerium	Ce	58	140.12
Cesium	Cs	55	132.905
Chlorine	Cl	17	35.453
Chromium	Cr	24	51.996
Cobalt	Co	27	56.933
Columbium	Cb	(See Niobium)	
Copper	Cu	29	63.54
Curium	Cm	96	(247)
Dysprosium	Dy	66	162.50
Einsteinium	Es	99	(254)

Based on Atomic Mass of $^{12}\text{C} = 12$

Name	Symbol	Atomic Number	Atomic Weight
Erbium	Er	68	167.26
Europium	Eu	63	151.96
Fermium	Fm	100	(253)
Fluorine	F	9	18.9984
Francium	Fr	87	(223)
Gadolinium	Gd	64	157.25
Gallium	Ga	31	69.72
Germanium	Ge	32	72.59
Gold	Au	79	196.967
Hafnium	Hf	72	178.49
Helium	He	2	4.0026
Holmium	Ho	67	164.930
Hydrogen	H	1	1.00797
Indium	In	49	114.82
Iodine	Ir	77	192.2
Iron	Fe	26	55.847
Krypton	Kr	36	83.80
Lanthanum	La	57	138.91
Lawrencium**	Lw	103	(257)
Lead	Pb	82	207.19
Lithium	Li	3	6.939
Lutetium	Lu	71	174.97
Magnesium	Mg	12	24.312
Manganese	Mn	25	54.938
Mendelevium	Md	101	(256)
Mercury	Hg	80	200.59
Molybdenum	Mo	42	95.9

Atomic Weights - continued

Name	Symbol	Atomic Number	Atomic Weight
Neodymium	Nd	60	144.24
Neon	Ne	10	20.183
Neptunium	Np	93	(237)
Nickel	Ni	28	58.71
Niobium	Nb	41	92.906
Nitrogen	N	7	14.0067
Nobelium	No	102	(254)
Osmium	Os	76	190.2
Oxygen	O	8	15.9994
Palladium	Pd	46	106.4
Phosphorus	P	15	30.9738
Platinum	Pt	78	195.09
Plutonium	Pu	94	(242)
Polonium	Po	84	(210)
Potassium	K	19	39.102
Praseodymium	Pr	59	140.907
Promethium	Pm	61	(147)
Protactinium	Pa	91	(231)
Radium	Ra	88	(226)
Radon	Rn	86	(222)
Rhenium	Re	75	186.2
Rhodium	Rh	45	102.905
Rubidium	Rb	37	85.47
Ruthenium	Ru	44	101.07
Samarium	Sm	62	150.35
Scandium	Sc	21	44.956
Selenium	Se	34	78.96

Based on Atomic Mass of $^{12}\text{C} = 12$

Name	Symbol	Atomic Number	Atomic Weight
Silicon	Si	14	28.086
Silver	Ag	47	107.870
Sodium	Na	11	22.9898
Strontium	Sr	38	87.62
Sulfur	S	16	32.064
Tantalum	Ta	73	180.948
Technetium	Tc	43	(99)
Tellurium	Te	52	127.60
Terbium	Tb	65	158.924
Thallium	Tl	81	204.37
Thorium	Th	90	232.038
Thulium	Tm	69	168.934
Tin	Sn	50	118.69
Titanium	Ti	22	47.90
Tungsten	W	74	183.84
Uranium	U	92	238.04
Vanadium	V	23	50.942
Wolfram	W	(See Tungsten)	
Xenon	Xe	54	131.30
Ytterbium	Yb	70	173.04
Yttrium	Y	39	88.905
Zinc	Zn	30	65.37
Zirconium	Zr	40	91.22

*Value in parenthesis () indicates most stable or best know isotope

**Proposed – not officially accepted

Metal Content of Plating Salts

Technical Name of Salt	Chemical Formula	Percent Metal
Antimony trichloride	SbCl_3	53.4
Cadmium cyanide	$\text{Cd}(\text{CN})_2$	68.3
Cadmium oxide	CdO	87.5
Chromic acid	CrO_3	52.0
Cobalt sulfate (anhydrous)	CoSO_4	38.0
Cobalt sulfate, crystal	$\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$	21.0
Copper carbonate (basic)	$\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$	57.5
Copper chloride (ic)	CuCl_2	47.3
Copper cyanide	CuCN	71.0
Copper sulfate (ic), crystal	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	25.5
Ferrous chloride, crystal	$\text{FeCl}_2 \cdot 4\text{H}_2\text{O}$	28.1
Ferrous ammonium sulfate	$\text{FeSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot \text{H}_2\text{O}$	14.2
Gold chloride (ic)	AuCl_3	64.9
Gold chloride (ic), crystals	$\text{AuCl}_3 \cdot 2\text{H}_2\text{O}$	58.1
Gold chloride (ous)	AuCl	84.7
Gold cyanide (ous)	AuCN	88.3
Gold potassium cyanide	$\text{KAu}(\text{CN})_2$	68.3*
Gold potassium cyanide, crystal	$\text{KAu}(\text{CN})_2 \cdot 2\text{H}_2\text{O}$	60.8
Gold sodium cyanide	$\text{NaAu}(\text{CN})_2$	72.5
Lead carbonate (basic)	$\text{Pb}(\text{OH})_2 \cdot 2\text{PbCO}_3$	80.1
Mercuric chloride	HgCl_2	73.8
Mercuric cyanide	$\text{Hg}(\text{CN})_2$	79.4
Mercuric nitrate	$\text{Hg}(\text{NO}_3)_2$	61.8
Mercuric nitrate, crystal	$\text{Hg}(\text{NO}_3)_2 \cdot \text{H}_2\text{O}$	58.6

Technical Name of Salt	Chemical Formula	Percent Metal
Nickel ammonium sulfate (double nickel salts)	$\text{NiSO}_4(\text{NH}_4)_2\text{SO}_4 \bullet 6\text{H}_2\text{O}$	14.9
Nickel carbonate (basic)	$2\text{NiCO}_3 \cdot 3\text{Ni}(\text{OH})_2 \bullet 4\text{H}_2\text{O}$	50.0
Nickel chloride, crystal	$\text{NiCl}_2 \bullet 6\text{H}_2\text{O}$	24.7
Nickel sulfamate	$\text{Ni}(\text{NH}_2\text{SO}_3)_2$	23.4
Nickel sulfate (single nickel salt)	$\text{NiSO}_4 \bullet 6\text{H}_2\text{O}$	22.3
Palladium chloride	PdCl_2	60.0
Platinum chloride, crystal	$\text{H}_2\text{PtCl}_6 \bullet 6\text{H}_2\text{O}$	37.7
Rhodium phosphate, crystal	$\text{RhPO}_4 \bullet 3\text{H}_2\text{O}$	29.9
Rhodium sulfate, crystal	$\text{Rh}_2(\text{SO}_4)_3 \bullet 12\text{H}_2\text{O}$	29.0
Silver chloride	AgCl	75.3
Silver cyanide	AgCN	80.5
Silver potassium cyanide	$\text{KAg}(\text{CN})_2$	54.2
Silver sodium cyanide	$\text{NaAg}(\text{CN})_2$	59.0
Silver nitrate	AgNO_3	63.5
Sodium stannate, crystal	$\text{Na}_2\text{SnO}_3 \bullet 3\text{H}_2\text{O}$	44.5
Tin chloride (ous), crystal	$\text{SnCl}_2 \bullet 2\text{H}_2\text{O}$	52.6
Tin sulfate (ous)	SnSO_4	55.3
Tungstic acid	H_2WO_4	73.6
Tungstic oxide	WO_3	79.3
Zinc cyanide	$\text{Zn}(\text{CN})_2$	55.7
Zinc oxide	ZnO	80.3
Zinc sulfate, crystal	$\text{ZnSO}_4 \bullet 7\text{H}_2\text{O}$	22.7
*Technically salts may contain appreciably less, and gold content is usually stated on container		

Concentrations of Common Acids and Bases

Name	Weight (%)	Specific Gravity (g/cc)	Normality
Acetic acid	99%	1.05	17.5
Ammonium hydroxide	30%	0.90	14.8
Formic acid	90%	1.21	22.15
Hydrochloric acid	35%	1.18	12
Hydrofluoric acid	48%	1.15	28.9
Methanesulfonic acid	70%	1.35	9.8
Nitric acid	67%	1.41	15
Phosphoric acid	75%	1.585	39
	85%	1.694	44.1
Solderon acid	50% methanesulfonic	1.25	6.9
Sulfuric acid	93%	1.84	36

$^{\circ}\text{F} = (^{\circ}\text{C}) (9/5) + 32$

$^{\circ}\text{C} = 5/9 (^{\circ}\text{F} - 32)$

$\text{cu ft.} \times 7.48 = \text{gal.}$

$\text{gm/l} \times 0.134 = \text{oz./gal.}$

$\text{oz./gal.} \times 7.5 = \text{gm/liter}$

$\text{gal.} \times 3785 = \text{ml}$

$\text{lb.} \times 453.6 = \text{gm}$

$\text{A/sq. ft.} \times 0.108 = \text{A/sq. dm}$

$1080 \times \text{Thickness in mils.} = \text{ASF}$

$\frac{\text{Plating Time (min.)}}{\text{ASF}}$

Plating Time

1 Amp	15 minutes
1.5 Amps	10 minutes
2 Amps	7.5 minutes
3 Amps	5 minutes
5 Amps	3 minutes

Amps/sq. ft.—267 ml or 534 ml Hull Cell

2 gm/267 ml Hull Cell = 1 oz./gal. = 6.25 lbs./100 gal. =

7.5 gm/liter

2 ml/267 ml Hull Cell = 0.96 fl. oz./gal. = 6 pts./100 gal.

1 Amp4	PANEL ← EDGE	03	02	52	01	51	21	08	64	32	10	.5			
		60	45	37	30	23	18	15	12	96	4.53	1.5	.75		
2 Amps		80	60	50	40	30	24	20	16	12	86	42	1		
		1209	07	56	04	53	63	02	41	81	29	63	15		
5 Amps		2001	50	1251	00	75	60	50	40	30	20	15	10	52	5
		<p>↑ TOTAL CURRENT</p> <p>HULL CELL SCALE</p>													

Hull Cell Scale