Chromium Alternative Solves Problem

Working together, the finisher, customer and supplier found the best solution to what could have been a costly finishing situation...

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In January of 2000, a U.S. manufacturer faced an interesting situation. One of the company's new parts required finishing; however, one of the finishing operations specified was an expensive prefinish. Eliminating the prefinish operation would save $2,000,000 a year, but could it find an appropriate substitute?

While on the surface this seems like a fairly simple request, it meant the development of a new coating from the ground up. So, the company approached MacDermid Inc., giving it the following directives concerning the finish characteristics.

To begin with, the finish had to have outstanding adhesion characteristics on aluminum, good wear, lubricity and corrosion protection, as well as specific hardness properties. Additionally, this new plating system had to be free of all toxic metals, such as chromium, nickel or cadmium. The application of the finish had to lend itself to process automation, and, most importantly, it had to be cost-effective. With these criteria in mind, the process engineers put together a list of potential finishes.

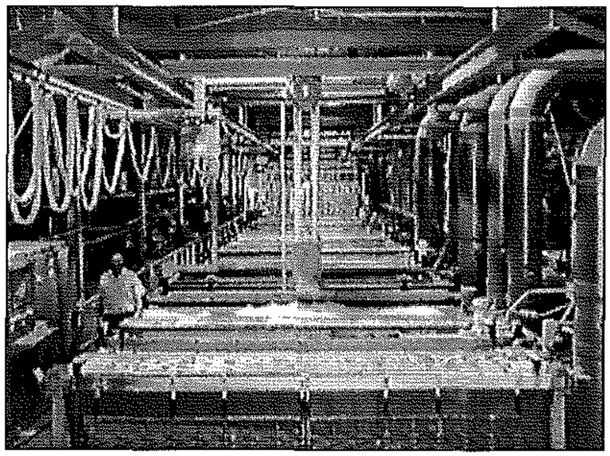
After weighing all the various alternatives, it was decided that a tin-cobalt alloy finish had the highest potential. Developed in Europe, this specialized plating process, Cromvert, produces a consistently uniform, tin-cobalt alloy finish. Its most common use is as a replacement for hexavalent chromium in decorative applications; however, it had not been tried before as a functional finish. The finish was selected because it combined the lubricity characteristics of tin and the hardness of cobalt. Additionally, since it is applied as a very thin coating, the process is cost-effective. (See Table I)

The process produces an intermetallic deposit consisting of 78% cobalt and 22% tin. The process can be used in barrel applications.

Once a finish had been selected, the project was moved to a pilot plating lab where sample parts could be run to evaluate the coating and design the proper process cycle. Countless parts were run, cycles modified and sample parts generated. Care was taken so that actual plating shop conditions were duplicated, in order to uncover any pitfalls. Once the process cycle was finalized, sample parts were generated for testing.

The testing process was extensive and rigorous. Adhesion, lubricity and wear resistance testing were performed both here and overseas. (See Table II) With some minor process adjustments, all test criteria were met or exceeded.

The next step was to locate a facility to do the plating. As this was a newly developed process, there weren't any applicators currently doing this work. This would mean that the plating shop would have to either install a new line or modify an existing one. Either way, it would require a significant financial commitment on the part of the plater.



New line at Techmetals sequences parts through the tin-cobalt alloy plating process. This finish is used as a replacement for hexavalent chromium. The line produces 15,000 parts per day and has saved the customers $2 million.

A nationwide search was made to locate a potential applicator. Audits were performed and candidates were rated on technical ability, laboratory capabilities, quality control and assurance programs, plant flexibility and overall plating knowledge. Of the dozens of potential shops evaluated, Techmetals Inc. (Dayton, OH) received the highest score and was chosen as the preferred applicator.

Now time was of the essence. Months of evaluating different finishes had gone by, and the part manufacturer was in danger of not meeting production demands. In a matter of weeks, Techmetals had to put together an entire plating line capable of producing 15,000 parts per day.

TABLE I - Cromvet Process Characterists v[illegible]

Parameters	Cromvet	Hex Chrome	Tri Chrome
Plating Speed	0.18 mm/min @ 0.5 Adm-2 (5 asf)	0.15 mm/min @ 12.0 Adm-2 (120 asf)	0.075 mm/min @ 5.0 Adm-2 (50 asf)
Current Density	0.3-0.5 Adm-2 (3-5 asf)	10-15 Adm-2 (100-150 asf)	5-10 Adm-2 (50-100 asf)
Voltage	2.5-3.0 V	16 V	12 V
Temperature	45C (113F)	40C (104F)	55C (130F)
Hardness	400-450 HV	850-1,100 HV	800-1,000 HV

Process engineers from both companies met daily. The supplier provided the process cycle and chemical know-how, while Techmetals had the expertise to take the project from a laboratory setting to full production. Within two weeks of winning the contract, Techmetals was up and running sample parts.

The first set of test parts performed exceptionally well. All the performance criteria were met, with one exception. One specific application required a minimum plating thickness be applied that exceeded what could be done with the new process. This was a major hurdle to clear, as there simply wasn't time to evaluate new finishes in the laboratory. A solution had to be found to this problem on a production scale before sales demands were interrupted.

Once again, engineers from the two companies met and considered various alternatives. Plating a higher thickness wasn't a viable alternative, so an alternate base coating would be required. All the same wear, corrosion and environmental considerations had to be met.

TABLE II - Cromvet Wear Resistance Properties

The test methods used conform to ASTM B 117/537. The abrasion test used is a modified version of ASTM D 968 (ASTM D 968-8) using 20 liters of sand instead of 100. The two ASTM specifications are partial fulfillment of the requirements of SAE Aerospace Standard AS4984.

AL ID No.	SOT ID No.	Original Weight (g)	End Weight (g)	Weight Loss (g)	Liters of Sand	Comments
P99-1431-1	47	28.6979	28.6961	0.0018	20	Ni/Alloy
P99-1431-2	45	28.0147	28.0129	0.0018	20	Ni/Alloy
P99-1431-3	14	27.0298	27.0288	0.0010	20	Ni/Cr

P99-1431-4	11	27.4001	27.4000	0.0001	20	Ni/Alloy
P99-1431-5	40	28.8190	28.8155	0.0005	20	Ni/Alloy
P99-1431-6	48	28.3729	28.3726	0.0003	20	Ni/Alloy
P99-1431-7	32	27.3022	27.3007	0.0015	20	Ni/Cr
P99-1431-8	10	27.6127	27.6112	0.0015	20	Ni/Alloy
P99-1431-9	25	23.5488	23.5485	0.0003	20	Ni/Alloy
P99-1431-10	20	27.4368	27.4360	0.0008	20	Ni/Alloy
P99-1431-11	22	22.8590	27.8583	0.0007	20	Ni/Cr
P99-1431-12	21	25.5163	23.5160	0.0003	20	Ni/Alloy
P99-1431-13	26	26.3119	26.3115	0.0004	20	Ni/Cr
P99-1431-14	24	26.4870	26.4861	0.0009	20	Ni/Cr
P99-1431-15	49	27.8553	27.8548	0.0005	20	Ni/Alloy
Ni/Cr X = 0.9 mg		s = 0.0004				
Ni/Sn/Co X = 0.8 mg		s = 0.0007				

After weighing all the possibilities, a base coating was selected and tested. The results were positive, and the project was back on track. This meant, however, that Techmetals faced a new challenge; having to retrofit a new process tank into an already existing line. This is a good example of why plant flexibility was so important in the initial plant audits.

The companies are happy to report that the line is now up and running full production. It is in operation 5 days per week producing 15,000 parts per day. The estimated cost savings to the part manufacturer is in excess of $2,000,000, and the use of hazardous metals has been entirely eliminated. This newly installed line has open capacity to process an additional 1,000 ft2/hr of aluminum parts in bright nickel, tin and Cromvet to meet future customer needs for either engineering or decorative applications.

Through the cooperation of the companies, a cost-effective, environmentally friendly, wear-resistant coating was developed and put into production to everyone's mutual satisfaction. It is an excellent example of how teamwork and shared knowledge can be used to solve industry problems.