The Chemist
Journal of the American Institute of Chemists

Improved Corrosion Protection Through Electrodeposition

George E. F. Brewer
Coating Consultants, Brighton, Michigan

Abstract: Dr. Brewer was cited as a 1978 Chemical Pioneer for his research in the electrodeposition of water-dispersed organic coatings. This invention is used in over 400 installations for the corrosion protection of automobiles, steel trusses, furniture, toys and many other objects. Advantages include absence of pinholes in the coatings, more efficient use of the paints, and absence of air pollution because no volatile organic solvents are used.

Key Words: Electrodeposition, Electrodeposition, Electropainting, and Elpo.

CHEMICAL PIONEER ADDRESS

One of my ideas, developed with the aid of farsighted men and years of devoted work, evolved into a process used worldwide for improving the corrosion protection of metal products. The process is variously called "Electrocoating," "Electrodeposition", "Electropainting," and "Elpo." It achieved special applications in the automobile industry where rusting was heretofore a continuing problem.

My grandfather's 1912 Ford Model T had lost all of its gloss by 1916, and I received a dime regularly for polishing it; yet it did not show rust when I drove it in 1932. In contrast, rust had eaten some holes into my own 1953 car by 1957, but the rest of the car was as shiny as new. Thus, the 1953 paint itself was more resistant. However, certain areas of the car body failed; a then very puzzling situation. Ultimately, I was able to resolve this puzzle.

In the late 1950s, I went to work for Ford Motor Company trying to develop waterborne paints for prime coating car bodies, and got familiar with the fact that the inner surfaces of spray-painted or dip-coated cars showed an absence of paint in some critical areas, where the rust starts, and destroys the car from the inside out. Actually, wet paint was originally deposited in all these recesses, but was washed off during the bake cycle through the action of condensing vapors, be they solvent or water.

What was needed was an essentially solvent-free paint, capable of permanently coating extremely recessed areas: a seemingly insolvable problem. **A new point of view**. Webster's Dictionary defines the term "invention" as the power to conceive and present new combinations of facts or ideas. If so, can we develop a technique of inventing? Yes, through storing and trying to recall vaguely related facts, and through looking at the problem from different vantage points. For instance, if everybody agrees that a zebra is a white horse with black stripes, it may pay to look at it as a black horse with white stripes.

In the case of painting merchandise, I decided that it was not really the paint solvent or carrier fluid per se which were troublesome, but rather the presence of carrier fluid during the bake. Looking at it this way, the problem was to remove the carrier fluid before the bake, and to reuse it, rather than to vaporize solvents during the bake. For about one year I thought and listed all possible ways, and not one seemed to be practical.

One evening while talking about my days in graduate school, I remembered that two classmates had had an explosion. They had tried to make rubber boots by "electrophoretic deposition of natural latex." All of a sudden it dawned on me that this was a separation of a colloid from its carrier fluid.

In 1808 Professor Reuss in Moscow observed that "milky" particles of clay migrate towards the anode in an electrical cell. He called this motion electrophoresis. Off and on the phenomenon was used as an analytical method culminating in Arne Tiselius' work for which he received the Nobel Prize in 1948. There were at least four significant attempts between 1919 and 1936 to use electrophoretic deposition in technical processes by use of naturally occurring products like rubber latex, beeswax, and asphalts. However, the parameters of an effective process for painting by electrophoretic deposition had not been defined, and no attempt had been made to synthesize suitable colloidal materials.

Numerous experiments with film formers such as epoxy resins, alkyds, acrylic, etc., resulted in the definition of parameters, such as range of viscosity, electrical equivalent weight, degree of neutralization, and so forth. The deposition process can be symbolized by the following chemical equations:

THE ELECTROCOATING PROCESS

Electrocoating resembles metal plating inasmuch as direct current is used. The electroplater applies 6 to 30 volts DC, while the typical electrocoater uses from 50 to 500 volts DC. The electrical equivalent weight of metal ions is approximately 30 (1/2 ni+ + = 29.36), while the average film forming macro-ion shows an electrical equivalent weight of 1,600. In other words, to plate out one kg of metal ions requires 34.1 Faradays of electricity, while one kg of electrocoat requires 0.63 Faradays. The electrocoating paint consists of about 90% water plus 10% paint solids, so it has the pumping and other handling characteristics of water. Merchandise is cleaned and prepared in the usual way, and then dipped into the painting tank where electric direct current deposits the paint. The merchandise is lifted from the paint after coating time, which varies from two seconds to three minutes. Droplets and puddles of undeposited paint adhere to the merchandise and are recycled by use of an ultra filtrate rinse.

The development of electrocoating has continued along various lines, and the process is now widely used for the coating of merchandise ranging in size from structural trusses to nuts, bolts, and electronic components. About 70% of all automobile bodies, world-wide, are prime coated by use of the electrocoating process.

The electodeposition of anodic electrocoats increases the life of the car body, and the recently marketed cathodic paints are expected to bring further improvements.

In all, the electrocoating process provides four improvements:

- Higher quality of product, largely due to the uniformity of the coat on all surfaces and in all recesses.
- Lower cost due to paint and labor savings.
- Less pollution since water is used as carrier fluid, and the rinsed-off paint is returned to the tank.
- Energy saving through elimination of intermediary drying operations.

Thomas Edison's attribution of success 1% inspiration and 99% perspiration was clearly evident in the efforts to commercially develop an electrocoating process for "painting" automobiles. Before the first car was electrocoated on an assembly line, approximately 150 man years of work were expended by chemists and engineers at Ford Motor Company. More than 75,000 panels were tested; some 10 million wheels were painted on an experimental line; approximately 150 experimental cars went to the test track and were evaluated. In addition, a large amount of work was done by leading paint manufacturers all over the world to provide suitable paints for electrocoating all sorts of merchandise. The technical details were reported in scores of papers and patents over my name as author, co-author, inventor, or co-inventor.

I am grateful to all of those who worked and still work on electrocoating and am proud that they remained my friends through all the pressures of two decades of work. Leading the list are the late Mr. Gilbert L. Burnside, my boss at Ford; Mr. Gordon G. Strasberg, the process engineer, and my wife Maxine, whose plans are frequently interrupted by emergencies in the field of electrocoating. The reward for all this work is the joy of overcoming adversities and the knowledge that I have made some contribution toward improving the quality of consumer goods. Naturally, I am gratified by the recognition of my fellow professionals, especially when it appears in the literature as follows: "Electrocoating… the greatest breakthrough since the invention of the spray gun. … the 1960's may go down in auto history… for giving birth to electrodeposition…"; "…benchmark in Chemistry…"; "…primer and single coats will be applied by electrodeposition almost universally…" I am thus especially grateful to have been named a recipient of the Institute's 1978 Chemical Pioneer Award.

NOTE

This paper is the 1978 Chemical Pioneer address of Dr. George Brewer, and it originally appeared in *The Chemist*, Volume 55, Number 7, p. 5 (1978). Source: Brewer, G. *The Chemist*, 1978, 55, 5. Copyright The American Institute of Chemists 1978.