

Summary of My Sixty Years in Chemistry

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There were only four teachers in the Chemistry Department of Indiana University in 1899 when I enrolled. The small numbers of students made possible valuable close personal contacts with the faculty. Mr. Brown got me interested in electrochemistry. Later I had the invaluable experience of work with Dr. Bancroft at Cornell both as teacher and, later, as a very helpful friend.

Electrochemistry is a small field compared to organic, physical, or inorganic. However, it is of vital industrial importance since there is no other way as satisfactory for making many things, i.e. aluminum, magnesium, chlorine, fluorine, etc. and, also, for electroplating.

In War I, I was called to Washington to try to make fluorine for use in poison gases. Since the only known method of preparation was electrochemical, it was assumed that any development would be in that field. This known process was so difficult to operate that no one had ever succeeded with it except a very few brilliant scientists in Europe and only small quantities had ever been produced. We failed with it in Washington. Along with other troubles this method required a low temperature of about -30°C .

The idea was chemically logical that compounds of carbon and fluorine might be prepared by using a graphite or carbon anode in some molten fluorine compound. It was assumed that fluorine would be formed first at the anode and that due to its exceedingly active chemical nature, an immediate reaction would take place forming some compounds with the carbon of the anode. It was, of course, possible that any such compounds might have the desired toxic properties since fluorine is in the same family with chlorine and the toxic war gases were chlorine compounds. Potassium acid fluoride, KHF_2 , had been used as one step in the Moissan process and was available in the laboratory. Also, it melted at about 200°C which was a very satisfactory working temperature. Electrolysis of this molten salt very unexpectedly gave free fluorine—the first time it had ever been made outside of Europe. As soon as the method was published, experimenters all over the world began using it in research. Today, a modification is used to make fluorine for one of the essential steps in preparing the atomic bomb at Oak Ridge.

Hitler used it and a modification, in making one of his "secret weapons, a poison gas that would spontaneously set fire to organic material such as clothing."

We never did find a toxic material but the present nerve gas is a fluorine compound that does not require any electrochemical step. This nerve gas is 75 times more toxic than mustard gas and 3500 times cyanide.

Graduate students have usually collaborated in the researches that have been mostly trying to improve the electroplating deposits. It is very necessary to have the electroplates as smooth and free from crystals or roughness or projections as possible. Some metals like nickel, copper, chromium, and others give excellent smooth plates or deposits without

much difficulty, but other metals, like tin and lead, give plates that are masses of loose poorly adhering crystals and great difficulty is encountered in producing plates in a smooth satisfactory form. Small quantities of certain organic substances, from 0.1 to 1 gm. per liter, will overcome the trouble.

The aim of the researches is to find the right organic compounds, but this problem has the added difficulty that a substance that will work with one metal may not work with another metal. These desirable substances have been named "addition agents" and they are absolutely necessary in lead and tin and some others.

Much research had failed to find anything for tin where glue was ineffective although excellent for lead. The problem was solved by using cresol along with glue. No one knows why or how these addition agents work, but they do.

In attempting to electroplate tellurium, it was observed (Papish) that many metals were darkened or given a black color by simple immersion or dipping in the tellurium solution without any electricity. A development from this observation has led to the use of tellurium to produce a so-called "oxidized" silver finish on silverware. This is a misnomer as the silverware is not oxidized at all, but it is colored by a thin film of tellurium or silver telluride which happens to be black. A way (Turner) was finally found for preparing excellent plates or deposits of tellurium.

These happy results from experiments designed for other things could be called "accidents," but the real facts were that all of us were working plenty hard and observing everything.

Some metals cannot be deposited at all from any solution containing water. Non-aqueous solvents are required. It was found (Dr. Blue) that aluminum bromide dissolved in ethyl bromide and benzene gave excellent aluminum deposits.

While attempting to separate or prepare a phenolic compound, said to be present in wood tar, it was found (Discher) that the tar itself in a tin bath would cause the electroplates to be bright and shiny like polished metal. The Tin Research Institute is pushing this commercially, and several companies are using it and tar preparations are on sale. It is worth mentioning that the Institute and other research laboratories as well as Dr. Discher, the discoverer, have not been able to find out what the active material in the tar is or how to separate it from the crude tar. What is being used is just what Dr. Discher recommended in his thesis and publication without any important change.

It has been necessary to choose these few researches since any attempt to talk about the more than 130 publications would be more than can be covered in a single lecture. Samples and some demonstrations of a few can be easily shown to the audience.