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Watts of Watts Nickel fame

D. R. Gabe

The name Watts has been synonymous with nickel plating for nearly 100 years, but who was Watts and where did he work?

Oliver Patterson Watts was an American academic chemist who was born on 16 July 1865 in Thomaston Maine and, having graduated from Bowdoin College in 1889, he took his PhD in 1905 and spent all of his working life at the University of Wisconsin until he retired in 1937. His own PhD was the first to be awarded in the newly formed Chemical Engineering department whose pioneering head was Prof. C. F. Burgess. He was an academic teacher primarily and so his output of research papers is relatively small but he was instrumental in commencing degree courses in Electrochemical Technology which grew into part of Chemical Engineering for which he wrote a very influential textbook in 1914 (Laboratory Course in Electrochemistry, McGraw-Hill). The obituaries emphasise his unassuming nature, his effectiveness as a teacher, and his ability to bridge the gap between university and plating shops. His interest in nickel plating was strong and he was a regular attendee at AESF Chicago branch meetings. He died on 6 February 1953 having enjoyed a long retirement of travel and outdoor activities.

Nickel plating was first reported in 1843 by Bottger, just three years after the Jacobi and Elkington announcements of commercial electroatplating. Bottger used a solution based on nickel ammonium sulphate hexahydrate which tended to give powdery deposits. From 1869 Adams used his patented process which made a number of claims but especially the need for solution purity and neutral pH. Smooth anode dissolution was recognised as a difficulty. The Adams patent expired in 1886 and revised formulations were being developed including the addition of boric acid (patented by Weston in 1878) and chlorides as sodium chloride (recommended by Bancroft in 1906). Other difficulties noted in the literature included poor faradaic control of thickness, irregular anode dissolution, dark deposits and difficulty plating on to zinc. Consequently, in 1911 the American Electroplaters Society (only founded in 1909) prompted Watts to research the solution and optimise it for reliable commercial usage. In 1913 and 1915, he reviewed the situation for the trade. and in 1916, published his considered opinion that an optimum solution should be based on:

- Nickel sulphate 240 g L⁻¹
- Nickel chloride 20 g L⁻¹
- Boric acid 20 g L⁻¹

By using it at 70°C ‘high speed’ electrodoposition (20–30 A dm⁻²) could be achieved, the cathode current efficiency was >90%, and the anode current efficiency 98–100%. He had already pointed out in 1915 that the use of a rotating cathode at 1000 rev min⁻¹ enabled current densities of up to 120 A dm⁻² to be attained.

The Watts formulation was adopted very slowly at first but its inclusion in the standard textbooks by Hogaboom and later, Field, helped to make it more widely known. The role of chloride in aiding smooth anode dissolution was generally appreciated but the role of boric acid as a pH 3–4 buffer primarily to minimise hydrogen evolution at pH<3 and discourage nickel precipitation as hydroxide at pH>6 was only slowly recognised. Watts himself wrote about boric acid in 1931 and his last paper also in 1931 was essentially a review on the state of adoption of his solution by industry.

The amazing record of Watts’ solution formulation is that it is still widely used today, but with organic additives of course, and its only serious rival has been the high speed sulphamate (150% higher nickel solubility) solution for electroforming applications. A number of update reviews have been written (e.g. Saubestre, 1958) whose main thrust for improvement has been an increase of total nickel salt content to ~350 g L⁻¹, boric acid increased to 30–50 g L⁻¹ and temperature reduced to ~55°C often as an energy saving measure.

Watts’ main papers on nickel plating are listed:


Watts’ wrote relatively few other research papers but covered a number of topics which were to become timely (elastic moduli of MoS₂, 1906; fused carbon, 1911). A number of papers on corrosion were published in the Electrochemical Society Transactions. Obituaries, and a celebration of his life shortly before his death, can be found as follows

J.Electrochem Soc. 1953, 100, 105C (see also ibid. 1952, 99, 277–278C).
Metal Fin. 1953, 51, 172 (June)
Plating 1953, 40, 781.