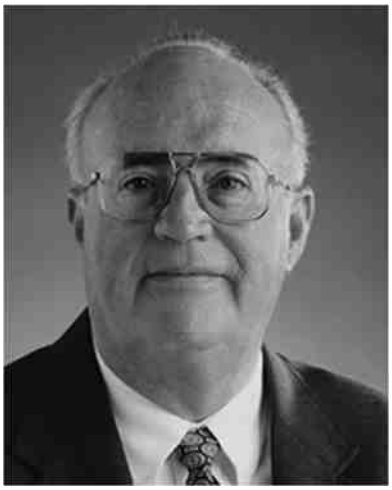
The 39th William Blum Lecture
Presented at the 85th AESF Annual Convention (SUR-FIN 1998)
in Minneapolis, Minnesota
June 22, 1998

Electrodeposition of Alloys

by
Christian E. Johnson
Recipient of the 1997 William Blum
AESF Scientific Achievement Award



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The NIST (NBS) Electrochemical Processing (Electrodeposition) Group of Today

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Editor's Note: This article is a summary of the 39th William Blum Lecture, presented at the 85th AESF Annual Convention (SUR/FIN 1998) in Minneapolis, Minnesota on June 22, 1998. A full paper was not made available, but material for the summary to follow was provided prior to the conference. A printable PDF version is available by clicking *HERE*.

SUMMARY

The National Institute of Standards & Technology (NIST) is fast-approaching its centennial anniversary in the year 2001, and the Electrochemical Processing Group will celebrate its century-long history in the year 2013. Not only have projects, programs, focus areas and personnel changed with time, but also the group and institutional names. While electrodeposition research and development at NIST has had an illustrious past under the leadership of Blum, Brenner, Ogburn and Lashmore, this lecture gives a brief account on each of the focus areas that exist within the group today. These include: Electrodeposition of aluminum alloys, electrochemical processing of nanoscale materials, electrochemical measurements of solderability for microelectronics, electrodeposited standard reference materials, advanced restorative dental materials, electrodeposition and characterization of chromium from trivalent electrolytes, and electrodeposited metallic glass alloys for orthopedic implants.

Discussed in the lecture were some of Mr. Johnson's many accomplishments during the course of his career. The following summarizes his work:

Chromium deposition and electroless nickel research

Described as a man of many talents, Johnson most notably is regarded as a leading expert in the areas of chromium deposition and electroless nickel. In his research, he determined that the microcracks and internal stress in chromium deposits from hexavalent electrolytes could be controlled by temperature and current pulsing. He theorized that hydride decomposition occurred during the off-cycle, which lowered the overall stress in the electrodeposit. He took this research further, and determined that by modulating the duty cycle, a layered structure could form that was comprised of layers of chromium with different levels of internal stress.

More recently, Johnson has been on the forefront of the development of electrolytes based on trivalent chromium species. He holds two U.S. patents in this area, and his expertise in this field is widely respected.

The Johnson Ultra-black

In 1980, Johnson developed and patented the blackest coating known to man. This patent has been recognized as a major contribution to absorptive coatings and is being considered as a baffel coating on the next generation of space telescopes. His method of producing an ultra-black surface coating with an extremely high light absorption capacity (spectral reflectance on the order of about 0.5-1.0% at wavelengths of light of about 320-2140 nanometers) has been useful as a solar collector in the field of solar energy and to minimize stray light scattering in optical systems. This patented coating can be applied to various substrates, such as metal, ceramic, glass or plastic.

Dental materials research

In another area, Johnson has developed a precipitation technology for producing a very pure silver coating that is suitable, when used with other existing NIST patents, for direct amalgam replacements for dental applications. This new material is in the advanced stage of ADA/NIDR certification process for biocompatibility, and is currently undergoing animal trials.

Standard reference materials

Johnson has been instrumental in the development of a number of physical reference standards now available to the public through the NIST Office of Standard Reference Materials. Among the more important of these is a set of microhardness standards produced by electroplating with extraordinary uniformity of properties. New gold and new ultra-high hardness standards also are being developed.

Particulate composite

During his career at NIST, Johnson has been a leader in the development of a family of particulate composite materials containing borides and various carbides that were tested on wiper blades at the Bureau of Engraving and Printing. This coating enabled these blades to extend their lifetimes from the original one to two hours to more than 48 hours. The cost of this test alone more than paid for the entire project.

About the author:

This material was written at the time Mr. Johnson was announced as the recipient of the 1997 Scientific Achievement Award and in the promotional material for SUR/FIN 1998.

Christian Edgar Johnson has been selected as the 1997 recipient of AESF's Scientific Achievement Award. The announcement was made during SUR/FIN '97 - Detroit in June. The Scientific Achievement Award is the Society's most prestigious honor.

Johnson is a physical scientist with the Electrochemical Processing Group at the National Institute of Standards and Technology (NIST), Gaithersburg, MD, formerly the Electrodeposition Group of the National Bureau of Standards (NBS). In his current position, he is principal or co-principal investigator of research programs on electrodeposition of chromium, chemical precipitation of metal powders, autocatalytic deposition, alloy electrodeposition, composition modulated alloys, metal matrix electrocomposites and standard reference materials. He has been with NIST/NBS since 1968.

Johnson has been active in the electrodeposition and coatings community for the past 36 years. From 1965 to 1968, he worked as an AESF (American Electroplaters Society at the time) research associate at NBS in Washington, DC. His earliest work (1961-1965) involved the development of electrodeposited permalloy for cylindrical thin film memories in the Solid State Device Group of Bell Telephone Laboratories, Murray Hill, NJ.

Throughout his career, he has made significant impacts in several technologically critical areas. These include, but are not limited to: The electrodeposition of copper, chromium and permalloy; electroless nickel; electrochemical coating of powders; electrochemically derived composites, and the structure/properties of electrodeposited coatings.

Johnson has written or been co-author on more than 35 papers, and is inventor/co-inventor on 11 patents. In one of his most significant publications, with Vernon Lamb, he developed the definitive study of the properties of electrodeposited copper(s) from the most widely used commercial electrolytes. This study was sponsored by the AESF Research Program, and is widely quoted and referenced throughout the industry. It is considered to be the best work done on copper.

In 1979, the U.S. Department of Commerce honored him with its Bronze Medal, and again in 1981 with the department's Inventors Award. He is a member of AESF's Baltimore-Washington Branch, the American Society for Testing and Materials

(ASTM), the International Standards Organization (ISO), American Society for Precision Engineering, and The Minerals, Metals & Materials Society.

In one of the letters in support of his nomination for this award, it states that "Chris Johnson has always maintained a strong presence in AESF, ASTM, ISO and TMS, and has served these societies with dignity and enthusiasm throughout his career. When one considers his longevity, technical impacts and service to the surface finishing community, it's difficult to put forth a candidate more deserving than Chris for this award."