Special Interest Talk
Room San Diego - Session SIT

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5:45pm **SIT-1 Tracing the Recorded History of Thin-Film Sputter Deposition: from the 1800s to 2018***, Joe Greene,* University of Illinois at Urbana-Champaign, USA

Thin films, ubiquitous in today's world, have a documented history of more than 5000 years. However, thin-film growth by sputter deposition, which required the development of vacuum pumps and electrical power in the 1600s and 1700s, is a much more recent phenomenon. First reported in the early 1800s, sputter deposition already dominated the optical-coating market by 1880. Preferential sputtering of alloys, sputtering of liquids, multi-target sputtering, and optical spectroscopy for process characterization were all described in the 1800s. Measurements of threshold energies and yields were carried out in the late 1800s, and results in reasonable agreement with modern data were reported in the 1930s. Roll-to-roll sputter coating on flexible substrates was introduced in the mid-1930s and the earliest demonstration of sustained self-sputtering (i.e., sputtering without the introduction of gas) occurred in 1970.

The term magnetron dates to 1921 and the results of the first magnetron sputtering experiments were published in the late 1930s. The earliest descriptions of a parallel-plate magnetron were provided in a patent filed in 1962, rotatable magnetrons appeared in the early 1980s, and tunable "unbalanced" magnetron sputtering was developed in 1992. Two additional forms of magnetron sputtering evolved during the 1990s, both with the goal of efficiently ionizing sputter-ejected metal atoms: ionized-magnetron sputtering and HIPIMS, the later now available in several variants.

rf glow discharges were reported in 1891, with the first results from rf deposition and etching experiments published in the 1930s. Modern capacitively-coupled rf sputtering systems were developed and modeled in the early 1960s and a patent was filed in 1975 that led to pulsed-dc and mid-frequency-ac sputtering.

The purposeful synthesis of metal-oxide films goes back to at least 1907, leading to early metal-oxide and nitride sputtering experiments in 1933, although the term "reactive sputtering" was not used in the literature until 1953. The effect of target oxidation on secondary-electron yields and sputtering rates was reported in 1940. The first kinetic models of reactive sputtering appeared in the 1960s; high-rate reactive sputtering, based on partial-pressure control, was developed in the early 1980s.

While abundant experimental and theoretical evidence already existed in the late 1800s to early 1900s demonstrating that the sputtering process is due to momentum transfer through near-surface collision cascades, the concept of sputtering due to local "impact evaporation" continued in the literature into the 1960s. Modern sputtering theory is based upon a linear-transport model published in 1969.

No less than eight Nobel Laureates in Physics and Chemistry played major roles in the evolution of modern sputter deposition.

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