

## Progress in Dielectric Science and Technology: Retrospective/Prospective

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Dielectric science has enjoyed a long and illustrious history. In addition, this long-standing branch of physics has had close links to chemistry and electrical engineering. Over 130 years ago, Faraday coined the term 'dielectric' to suggest that something analogous to current flow occurs through a capacitor structure during the charging process when current introduced at one plate 'flows' through the insulator to charge the other plate. It is generally accepted that a dielectric material interacts with an electric field differently than does free space because the dielectric contains charges that can be displaced. Since nearly all materials contain charges, essentially every material can be broadly classified as a dielectric.

The Dielectric Science and Technology (DS&T) Division of The Electrochemical Society has also had a long and illustrious history. The Division was founded in 1945 as the 'Electric Insulation Division', in large part as a result of the efforts of F. M. Clark, organizer of the Insulation Research Laboratory at General Electric. This Division offered an interdisciplinary forum for discussions on electrical insulation as applied to power transmission, e.g., cables, transformers, and capacitors. In the July, 1952 issue of *The Journal of The Electrochemical Society*, T. D. Callinan, then Chair of the Electric Insulation Division, stated that the Division was formed to "promote the attainment and dissemination of knowledge of dielectrics, including the electrical, mechanical, and chemical properties of nonconductors of electricity. Included are four branches of specialized study such as Theoretical Dielectrics, Materials, Instrumentation and Measurement, and Applied Dielectrics (such as Electrical Insulation)." In this article, Callinan remarked that the interest in this field was shifting from "power transmission to intelligence transmission", and implied that the recent discovery of the transistor would have a major impact on the field of dielectrics. This prophetic comment in 1952 has proven to be a cornerstone of the Division's development.

Consistent with Callinan's original *raison d'être*, DS&T provides a forum for scientists and engineers to exchange information, ideas, and directions through sponsored and cosponsored symposia, proceedings volumes, and discussion sessions. However, the Division has changed technical focus since 1945, in response to the interests of its members and to ever-changing applications for dielectrics. For example, until ~1960, symposia sponsored by the 'Electric Insulation Division' involved electrophysics, electrical properties of plastics, wet electrolytic capacitors, wires and cables, inorganic and organic dielectrics, high temperature insulation and dielectrics, liquid dielectrics, prefabricated circuitry, and chemical aspects of printed wiring. As predicted by Callinan, development of the transistor and subsequent miniaturized electronic circuitry, led to a change of emphasis of the Division. Consequently, a name change was instituted in 1965, when the Division became the

Dielectrics and Insulation Division. Symposia held from 1965 to 1988 include anodic oxide dielectrics for electrolytic capacitors, thin films for electronic applications, plasma processing, silicon nitride and silicon oxide thin insulating films, chemical vapor deposition, and multilevel metallization; some of these symposia were sponsored jointly with the Electronics Division and/or the Electrothermics and Metallurgy (now the High Temperature Materials) Division. In 1990, again responding to changing interests of our members, the Division's name became Dielectric Science and Technology (DS&T). Since 1989, symposium topics such as diamond and diamond-like films, corrosion and reliability of electronic materials and devices, III-V nitride materials and devices, ULSI science and technology chemical mechanical polishing, environmental issues with materials and processes for IC manufacture, rapid thermal processing, and polymeric materials for ICs have been added; as before, some of these symposia are jointly sponsored with other ECS Divisions and other professional societies.

In 1967, DS&T established an annual award to recognize individuals who have made outstanding contributions to the field of dielectrics. This award honors T. D. Callinan, twice chair of the Division, who had a major impact on the operation and development of DS&T. Consistent with the breadth of symposium topics, the list of awardees identifies individuals involved in a large array of research areas.

Clearly, the DS&T Division has undergone significant change and evolution since its inception. These changes mirror the interests of our members, and hence the science and technology involved in the electronics/microelectronics industry. The DS&T retrospective/prospective symposium will celebrate the Division by a series of four talks by prominent scientists and engineers who have had a major impact on the development of dielectric materials and processes. These individuals have also had leadership roles in DS&T or allied Divisions. Specifically, symposium topics will follow the evolution of dielectrics and their associated process technology from insulation and capacitors to the low and high dielectric constant materials required for current ICs. Within this context, the speakers will describe the development of materials and processes during the phenomenal advances of microelectronic devices and ICs. In addition, they will describe future needs and requirements for dielectric materials. The symposium will conclude with discussion/suggestions by the audience and speakers to assist the planning of future DS&T symposia and other activities.