Preface for the AVS Peter Mark award 40th anniversary collection

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The year 2020 is the 40th anniversary of the AVS Peter Mark Memorial Award, a high honor bestowed upon an early career scientist or engineer to recognize their outstanding theoretical or experimental research and contributions to scientific knowledge in the topical areas championed by AVS. In 2020, Professor Rehan Kapadia became the 40th recipient for “pioneering work in hot-electron emission and electrochemical devices.” The award is a memorial to Dr. Peter Mark, who served as the Journal of Vacuum Science and Technology (JVST) Editor from 1975 until his death in 1979. First established in 1979 with an endowment from the AVS Greater New York Chapter, significant additional contributions were made by Hans and Herman Mark, the AVS Electronic Materials Processing Division, the Physics of Compound Semiconductor Interfaces Conference, and several individuals.

The authors of this preface are all previous Peter Mark Memorial awardees and current editors of JVST. Being a Peter Mark Memorial awardee is not a requirement for being a JVST Editor, but it is also not a coincidence. It speaks to the legacy of Dr. Mark, who cultivated outstanding research when he was alive and continues to nurture the future leaders of AVS after his death through the award in his name. We all know that the expectations of the Award are high - a responsibility to propagate Dr. Mark’s vision of a high-quality journal for authors to publish their latest breakthroughs, particularly those at the early stages of their scientific careers.

Dr. Mark (Fig. 1) was born in 1931 in Mannheim, a university town southwest of Germany. Escaping with his family from the Nazis, he came to the United States in 1939 when he was just eight years old. The Mark family had lived in Vienna for a time before escaping the Nazi annexation of Austria via Switzerland, and they ended up in London just before France collapsed. Dr. Mark’s father, Herman Francis Mark, was a prominent polymer chemist who found a position at a Canadian paper company and had to leave London without the rest of the family. Finally, the family was reunited in Hawkesbury, and shortly after, they moved to New York. Herman Mark ended up founding the Polymer Research Institute at Polytechnic Institute of Brooklyn, now New York University Tandon School of Engineering, where one of the authors (Aydil) is a faculty member. It is kismet that Aydil’s office is on the floor where Herman Mark once walked and that an award named after his son hangs on Aydil’s office wall that was possibly once Herman Mark’s lab or office. Both of Herman Mark’s sons became illustrious scientists or engineers. Peter Mark’s older brother (by two years), Hans Michael Mark, is a former Secretary of the Air Force, a former Deputy Administrator of NASA, and Professor Emeritus at the University of Texas at Austin.

Dr. Mark received his B.S. from Harvard College in 1953 and his Ph.D. from New York University in 1958, both in Physics. His Ph.D. advisor was Prof. Hartmut P. Kallmann, a renowned expert on scintillation and gamma-ray detection. Peter Mark’s thesis was entitled “AC impedance measurements of specially activated zinc-sulfide and zinc, cadmium-sulfide phosphors in powder form,” undoubtedly motivated by Kallmann’s interests in scintillation.1

After receiving his Ph.D., Dr. Peter Mark joined Polaroid as a senior research physicist, where he worked for 14 years until 1972...
when he joined Princeton University as a faculty of the Electrical Engineering and Computer Science department. He taught and conducted research there until his death. He was a loyal member of the AVS and served not only as the Editor of its flagship journal (1975–1979), but also as the Greater NY Chapter Chair (1970–1972), AVS Director (1974–1975), AVS Membership Chair (1974), and Thin Film Division Chair (1975). When Dr. Mark became Editor of JVST, he helped expand the AVS community into compound semiconductors, lithography, device fabrication, and device physics. Papers from conferences such as Physics and Chemistry of Semiconductors and the Electron, Ion, and Photon Beam Conference, known as the “three beams conference,” were brought into the AVS community during Dr. Mark’s tenure and continue to be published in JVST today. His research interests aligned with these topics and centered around understanding surfaces and interfaces and their effects on phenomena that determined how devices comprising these surfaces and interfaces function. He published nearly 100 articles on a broad range of topics. For instance, he was interested in the polarity of various ZnO surfaces. He was an expert in low-energy electron diffraction (LEED) and used it to discover and understand surface reconstructions. Tetrahedrally-coordinated compound semiconductors such as GaAs, CdS, ZnS, ZnO, etc., were favorites. While fundamental surface science studies were a significant fraction of his publication list, one of his most cited papers, which continues to be referenced to this day, is on a thin-film SnO₂ sensor for detecting CO. The majority of his research was aimed at understanding the role of surfaces, surface preparation methods, and interfaces on properties crucial for devices made from compound semiconductors. For instance, one of his papers was concerned with Schottky barriers formed on ordered and disordered GaAs surfaces. The aim was to resolve inconsistencies in measurements and understand their origin. Through painstakingly detailed experiments, they showed that the Schottky barrier formed between Au and GaAs is very sensitive to inhomogeneities introduced during the steps employed in cleaning the surface.

Dr. Mark’s last article was published posthumously with a note that read, “Professor Peter Mark died on September 26, 1979, while this paper was being written. We would like to pay a very special tribute to him, to the man and the scientist he was. The whole Princeton group is deeply saddened by his death, but we all feel honored and proud to have worked with him.” Fittingly, it was on interactions of O with GaAs investigated using LEED, his favorite surface studied with his favored method. Antoine Kahn, the first author of this article and the last Ph.D. student to graduate under the direction of Dr. Peter Mark remembered him as an “extraordinary mentor.” Antoine Kahn is now a Professor at Princeton University Electrical Engineering Department.

Contemporaries of Dr. Mark remember him as a brilliant, amiable, and friendly person. Bill Westwood, a longtime AVS member, recalled that Dr. Mark once arranged with his brother to have an admission ticket waiting at Cape Canaveral for Bill to attend a rocket launch. Everyone remembers Dr. Mark as always being cordial at the Board meetings, even when the discussion topics may have been contentious. There are very few pictures and close friends surviving the time, but by far, the best one by consensus is one taken at a meeting at Philadelphia (Fig. 2). Peter Mark is in the middle of the back row. This photograph also shows Charlie Duke (white jacket next to Peter Mark), a close collaborator of Peter Mark. Antoine Kahn recalls fondly driving, with Peter Mark, from Princeton to Webster (Xerox) several times to collaborate with Charlie Duke.

This special issue features theoretical and experimental work by scientists who have been selected to receive the Peter Mark Memorial Award over its 40-year history. The awardees are scattered in academia, government labs, and industry. Some are retired, and others have changed fields. The collection comprises 15 articles from 16 of the awardees: one is a collaboration between two...
awardees and coauthors of this preface, JVST Associate Editors, who reported their latest work on molecular beam epitaxy of TbAs on GaAs. The collection also includes an article by the first Peter Mark Awardee, Christopher Brundle, who is as careful as ever and reported on how to properly analyze X-ray photoelectron spectra for a material of current importance, LiF. Dr. Mark’s brother Hans Mark handed Dr. Brundle his award certificate at the AVS Symposium in 1980. Some of the award recipients went on to have an enormous impact in the semiconductor industry. Still, their executive positions did not stop them from publishing scientific articles in JVST. For instance, Rick Gottscho, the 1986 awardee and Executive Vice President and Chief Technology Officer at Lam Research, contributed, with his group, an article on atomic layer etching (ALE) to propose a universal scaling relation that unifies the low-energy long-exposure and high-energy short-exposure ALE regimes. They suggest this scaling as a useful and practical guide for designing ALE processes for etching applications in the semiconductor industry. Steve Rossnagel, the 1990 awardee and a magnetron sputtering expert we recently honored with a special issue on the occasion of his 65th birthday, wrote a must-read review on this topic. The more recent awardees published on the latest materials they have been investigating. These include 2D chalcogenides, lithium-ion battery cathodes, and phase change materials. The entire collection is available on the JVST Scitation platform.

Working on this Special Collection, researching Dr. Mark, and writing this preface has been emotional for all of us. More than forty years after his untimely death, Dr. Mark’s vision and legacy are kept alive, in the Journal he once edited, by his friends, collaborators, recipients of the award that carry his name, and their academic and scientific descendants.

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REFERENCES