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Editors: D. Adler, A. Madan and M. J. Thompson
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Materials Issues in Applications of Amorphous Silicon Technology

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EDITORS:

D. Adler
Massachusetts Institute of Technology, Cambridge, Massachusetts, U.S.A

A. Madan
Glasstech Solar, Inc., Wheat Ridge, Colorado, U.S.A.

M. J. Thompson
Xerox Palo Alto Research Center, Palo Alto, California, U.S.A.

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Pittsburgh, Pennsylvania

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PART XIV: HETEROJUNCTION AND POLYCRYSTALLINE DEVICES

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Preface

Over the past few years, the present and potential applications of amorphous-silicon-alloy thin films have mushroomed, and interest in the materials as well as in the device has grown accordingly. The field has evolved rapidly since the accidental discovery of hydrogenated amorphous silicon (a-Si:H), an alloy whose semiconducting properties proved much superior to those of pure amorphous silicon because the overall reduction of network strains due to the univalency of hydrogen taken together with the strength and polarity of the Si-H bond leads to sharp reductions in the concentrations of both traps and recombination centers in a-Si:H. The initial application of a-Si:H and related alloys such as a-Si:F:H was in the area of photovoltaic energy conversion, since here the cost of devices based on crystalline silicon (c-Si) precluded their widespread use on economic grounds. The development of large area photovoltaic devices further stimulated the field, and even a continuous-web process has been demonstrated. Since it is also possible to tune the bandgap using, for example, Si-Ge and Si-C alloy films, the possibility of ultra-high-efficiency multiple-gap stacked solar cells is particularly exciting. Unfortunately, high-quality hydrogenated amorphous Si-Ge and Si-C alloys initially proved to be more difficult to develop than a-Si:H, but recent progress especially with alloys also incorporating fluorine has been very encouraging. Another potential cloud has been the metastable instabilities that characterize a-Si:H films exposed to sunlight for extended periods, but again recent advances in both understanding the effect and judicious processing of the materials and the overall device geometry has suggested that any stability problem can be overcome.

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The demonstration of large-area processing of high-quality films has also revived interest in the fabrication of thin-film transistors, especially for use in flat-screen displays. Another potentially enormous application of amorphous silicon alloys, viz. as the photoreceptor for electrostatic copying, requires rapid deposition rates, and here again recent progress has been extremely exciting. The development of amorphous-silicon-alloy photodiodes for use in image sensors and compact scanners has also evolved rapidly, as has the materials use in switching and memory applications, in laser printers, and in an array of other possibilities.

Concomitant with this exponential growth in the device potential, there has been further progress in materials processing. Novel approaches to chemical vapor deposition have been developed and periodic multilayer structures have been shown to exhibit unique properties such as persistent photoconductivity (for several hours at room temperature). Clearly, the entire area is in a period of rapid growth.

It was in this milieu that the MRS Symposium on Materials Issues in Applications of Amorphous Silicon Technology took place in April 1985. Over 200 scientists from around the world participated. The present volume contains 60 papers, including all the invited presentations as well as the vast majority of both the oral and poster contributions. The volume is divided into 14 parts, and is concerned with both materials processing and characterization as well as device applications. Part I contains nine papers devoted to the deposition, growth, and crystallization of amorphous-silicon-alloy films. In particular, there has been a great deal of recent interest in alloys prepared by chemical vapor deposition, especially from disilane (to keep the temperature sufficiently low to insure that significant concentra-

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tions of residual hydrogen are incorporated in the films. Since the quality of the material is directly related to the defect concentration, the overall issue of defects is of vital importance. The two papers of Part II are concerned with both the nature and the physical consequences of defects in amorphous-silicon-alloy films.

All devices involve interfaces between the amorphous silicon alloy and other semiconductors, metals, or insulators. The five papers in Part III deal with the properties of a variety of such interfaces, all of potential commercial importance. As an interesting extension of some of these considerations, Part IV consists of two papers on novel periodic multilayer devices employing alternating amorphous-silicon-alloy films of individual thicknesses as low as 10 Å.

The 14 papers comprising Parts V through VIII are all concerned with alloys, especially those useful for bandgap modulation. In particular, Si-Ge alloys are the subject of Part V, Si-C alloys of Part VI, Si-N alloys are discussed in Part VII, and the properties of some miscellaneous alloys are reviewed in Part VIII. The large fraction of the present volume devoted to alloys reflects the excitement attendant with the possibility of stacked high-efficiency solar cells for use in central-power generation.

The remainder of the volume is directly concerned with specific applications. The six papers of Part IX make clear the striking advances in solar-cell technology that have occurred over the last year, while the six papers of Part X demonstrate how our understanding of photo-induced effects in these films has progressed concomitantly. Part XI consists of eight papers, more than one-quarter of all the papers deal with devices, all concerned with the physics and performance of thin-film transistors and diodes involving amor-

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phous-silicon-alloy films. The papers in Part XII are devoted to photoreceptor applications, while image sensors and related devices are discussed in Part XIII. Finally, the two papers of Part XIV analyze amorphous-crystalline heterojunction transistors and thin-film devices involving polycrystalline silicon. Taken together, the 29 papers concerned with devices eloquently demonstrate the current state of the art.

We the organizers were pleasantly surprised with the strong positive response to the symposium. It was unanimously decided to hold a similar symposium at the 1986 MRS Spring Meeting. From our present perspective, it would appear that even a more enthusiastic response may well result next year.

David Adler

Arun Madan

Malcolm J. Thompson

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