Amorphous Silicon Solar Cells

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Translated by
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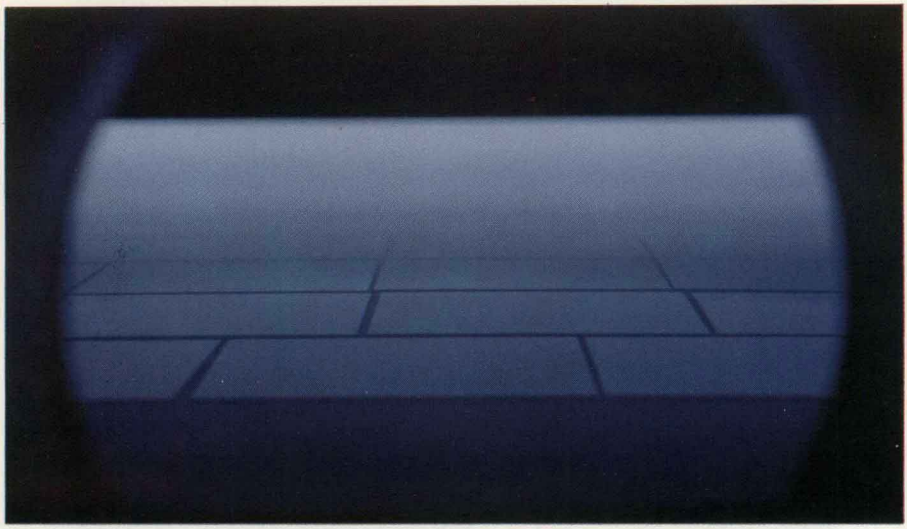
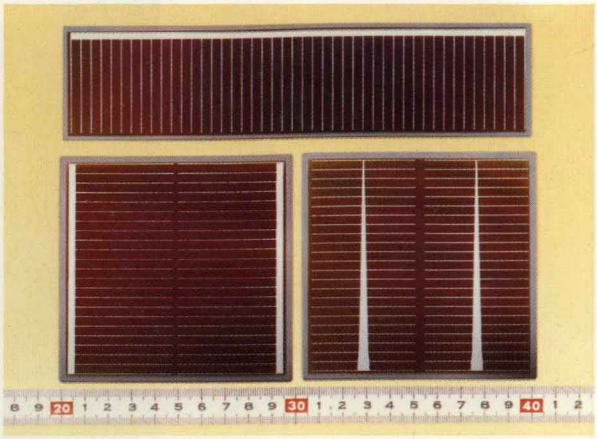
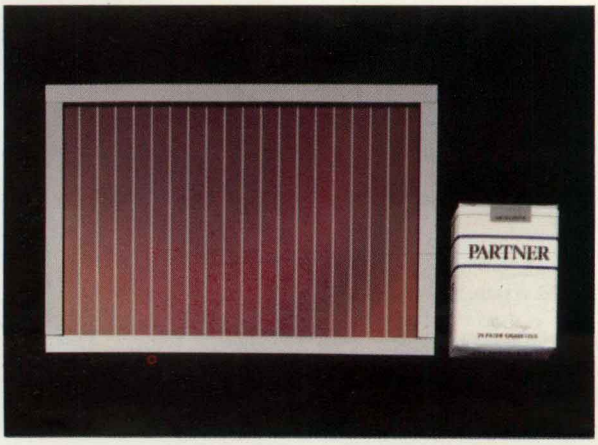


(1) *High frequency glow discharge using silane gas (photograph supplied by Fuji Electrical Company).*



(2) *Large-area amorphous Si solar cells formed on a stainless-steel substrate (photograph supplied by Fuji Electrical Company).*



(3) *Amorphous Si solar cell module of the single substrate type, measuring 15 × 22cm (photograph supplied by Fuji Electrical Company).*

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(4) *Amorphous Si solar cell formed on a flexible (macromolecular) film (photograph supplied by Teijin).*

(5) *Amorphous Si solar cells formed on a flexible film (photograph supplied by Teijin).*

(6) *Example of an application of amorphous Si solar cells formed on a flexible film (photograph supplied by Teijin).*

(7) *A 2.5kW power generation system employing amorphous Si solar cells (at O-okayama campus, Tokyo Institute of Technology).*

(8) *Use of amorphous Si solar cells in consumer products (photograph supplied by Sanyo Electrical Company).*

(9) *Use of amorphous Si solar cells in consumer products (photograph supplied by Sanyo Electrical Company).*

(10) *Hybrid power generation system on an Indian reservation using a windmill and monocrystal Si solar cells for drawing up water. The solar cells power the well jack pump (Sweetwater, New Mexico).*

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Preface to English Edition

Research and development of amorphous silicon solar cells is being carried out in many countries and such cells are now being used for practical generation of electrical power, replacing the previous generation of monocrystalline silicon solar cells.

At such a time, we are very pleased to see our book *Amorphous Silicon Solar Cells* being translated and published in English, the international language of science, and in England, the homeland of that language.

Our sincere gratitude is due to Dr. Stuart Sharrock of North Oxford Academic Publishers Ltd for his support to the English edition of this work. Our heartfelt thanks also go to Mr F.R.D. Apps, who translated the book from Japanese into English.

We shall be delighted if this book can contribute to the practical use of amorphous silicon solar cells, by being of assistance to technologists and those, throughout the world, who are conducting research in this field.

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Preface to Japanese Edition

Amorphous solar cells are becoming important in energy-related fields all over the world. Indeed in Japan, amorphous solar cell R & D, which was begun as a national project in 1980, has now made the leap from basic research to partial applications research. The level of amorphous solar cell R & D in Japan is now the highest in the world, and one might say that we have become the Mecca of this field of research, watched avidly by all other countries.

The reason why amorphous solar cells excite such great interest is that they have unique features not possessed by conventional monocrystal silicon solar cells.

Now that the amorphous solar cell national R & D project has moved on from basic research to partial applications research, there is widespread demand for the publication of a book covering all the basic R & D to date. This book is a response to this demand.

As this book is the very first on amorphous silicon solar cells, not only in Japan but also overseas, I felt it such a great responsibility that I debated whether to write it or not. However, hoping to receive correction from the reader and make a contribution, however small, to the development of amorphous solar cells, I summoned up courage and took the plunge.

For those who wish to know what solar cells are and for those engaged in the development of future amorphous solar cells, I first discuss the operating mechanism of solar cells and conventional types of cell as an introduction to amorphous solar cells. I have included plenty of data and illustrations, etc. for the convenience of those already involved in the development of amorphous solar cells.

Although, to our regret, the seed of the amorphous solar cell idea was sown in America rather than in our own country, it has taken deep root in Japan, where major development work has taken it from seedling stage to full maturity. If this new technology stands like a tree in Japan, we hope that it will put out shoots in every country throughout the world; and if this book contributes to that process, it will be a great satisfaction to its author.

For readily permitting the use of data and other information obtained in the course of the national project and for comprehensive assistance with the publication of this book, I am deeply grateful to all those concerned with MITI's Sunshine Project, especially to Development Officer Mr. Hirano.

I am also very grateful for the photographs, data, etc. provided by various people.

Finally, I offer sincere thanks to Mr. Takao Kobayashi and Mr. Michio Yamada for meeting all my strict demands regarding the publication of this book.

Summer 1983

Kiyoshi Takahashi
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Part I

The Fundamentals of Solar Power

1

Solar cells and solar power

1.1. The status of solar power*

1.1.1. Characteristics of solar power

Solar power has attracted attention of late as the ıost advanced of the alternative energy resources. Solar power generation xploits the properties of solar cells, which generate d.c. electricity when li ıt falls on a cell made from the p-n junction Si (silicon) material as is used f transistors and integrated circuit elements. Illumination by sunlight of a n^2 array of such cells can produce power of the order of 100 W.

As alternatives to oil, a number of energy resourc merit consideration. Table 1.1 lists representative alternative energy reso ;es, their characteristics and drawbacks. As an energy resource, solar p ver has the following advantages:

1. Solar energy is free and in inexhaustible supply

2. Solar power generation produces neither residue or exhaust gases, and thus is non-polluting – solar energy is a 'clean energ .

3. Since solar cells convert light energy directly ıto electrical energy, there are no moving parts such as the turbines and g erators needed in the thermal power, atomic power and wind power gener on processes. Therefore, maintenance is simple and automation and u ıanned operation are feasible. Such factors make it a desirable power sourc for satellites, unmanned lighthouses and in desert locations.

4. Electricity can be generated where it is needed. ince the solar power conversion rate is constant, irrespective of the scale o he system employed, the power can be generated where it is required, in nounts ranging from very small (for items such as wristwatches and calcul rs), through medium (for private houses and multiple dwellings), up to v y large (e.g. several hundred kilowatts), without needing power tran ıission lines. With localized power generation at the place of consumptic , the need for a power distribution transmission line system disappears.

5. As solar cells have a useful life in excess of tw ty years, they can be considered as long-life devices.

* 'Solar power' means 'solar light power' in this book.

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