Sphelar Cells Save on Silicon, Capture Light From All Paths

A realization is emerging that the earth's sources of fossil fuels, food and energy are exhaustible and insufficient to support the growing global population. At the same time, many scientists warn about the threat of global warming, the apparent consequence of widespread and long-term burning of fossil fuels. Every day, newspaper articles describe environmental problems.

Meanwhile, society is not make full use of natural energy, especially the inexhaustible light energy from the sun. The need is urgent for living spaces that fully use natural energy. Like modern people suffering from lifestyle-related diseases, the earth is also ailing. The cure is to change the living space itself.

Sphelar Spherical Solar Cell

Recently, spherical solar cells have drawn attention mainly because spherical solar cells, which are produced directly from molten silicon, significantly reduce the waste of raw materials by eliminating "Kerf loss" caused by slicing silicon ingots into wafers in the conventional method. Silicon shortages in recent years are stimulating this trend toward spherical solar cells, which use less silicon and therefor should eventually cost less than conventional cells.

However, lower cost is not the only benefit of spherical solar cells over conventional cells. In the natural world, light comes directly from the sun but also from reflected light and diffused light. Indoors, light comes from all directions. Kyosemi Corp. has found that by making the light-receiving surface spherical to take in light from all directions, power generation capacities can be increased.

People usually think of light coming from one direction only. Therefore, people assume that a spherical shape has poor light-intercepting efficiency compared with a planar surface. Hence, some people conclude that a spherical shape is unsuitable for a solar cell. Kyosemi thinks otherwise. Since 1994, Kyosemi has devised spherical cell structures, has developed an original process on the basis of this concept, and has brought out several modules. In 2004, Kyosemi registered Sphelar as a trademark for the company's spherical solar cells. Sphelar cells are small, measuring about 1mm to 2mm across, enabling the creation of modules in many different shapes, as well as transparent and flexible modules. In addition, Sphelar cells can be connected in series or in parallel. Applications to high-voltage modules can also be anticipated. Furthermore, Sphelar cells are durable, and their material is recyclable. With these characteristics, Sphelar cells are promising tools for the construction of living space in the 21st century.

12-cell module

Characteristics

Product	Configuration		Characteristics			Status
	Seri	Para	Voc(V)	Isc(mA)	Pmax(mA)	
KPS-F12-1s12p-S	1	12	0.6	30	13.5	ES
KPS-F12-2s6p-S	2	6	1.2	15	13.5	under deve
KPS-F12-3s4p-S	3	4	1.8	10	13.5	ES
KPS-F12-4s3p-S	4	3	2.4	7.5	13.5	under deve
KPS-F12-6s2p-S	6	2	3.6	5	13.5	under deve
KPS-F12-12s1p-S	12	1	7.2	2.5	13.5	under deve

Fig. 2: Example of low-power-application module

Kyosemi's Strategy

Currently, research and development of Sphelar cells is at the final stage and the company is gearing up for the standardization, mass production and automatic production of products (Fig. 1). However, there are difficulties unique to spherical cells in the production and assembly processes. Sphelar cells currently cannot meet applications for supplying large power in terms of production capacity. Also, it is too early to take advantage of the cost benefits of spherical solar cells.

However, Kyosemi has developed a commercial application for Sphelar cells involving a wireless information terminal without a conventional power supply. This information terminal uses a Sphelar cell to receive both power and information through infrared light. The terminal was displayed at the 2005 World Exposition, Aichi, Japan.

Fig. 1: Technology roadmap for Kyosemi

In promoting Sphelar cells, Kyosemi focuses attention first on high-value-added small low-power-consumption products that make the most of Sphelar's characteristics for accommodating transparent and flexible modules in a variety of shapes and for accommodating designers who want flexibility in selecting voltage and current (Fig. 2). With these characteristics, Sphelar is perfect for light and compact mobile products and has a potential to become an alternative to disposable batteries. About 50 years ago, transistors were introduced in the electronics industry, taking the place of vacuum tubes and leading to the appearance of compact radios. Sphelar cells may play a similar role as transistors in transforming the market. Another application for Sphelar cells is in small sensors. By installing various sensors and by having them communicate with one another, sensor networks can be formed, making possible widespread wireless monitoring of the environment, including measurements of temperature, humidity, wind direction and environmental pollutants. Other applications for such sensors could include factory automation and logistics. Meanwhile, the Sphelar applications in biosensors offer the potential of enabling better health care at home. Yet another application for Sphelar cells is as a tag that transmits information in devices, for example, for securing the safety of school children on their way between school and home, and for devices in the area of food safety. Each application will create a new market. Furthermore, as Sphelar modules can capture light from all directions, it is possible to drop sensors from the sky without regard to the direction of the sun. Such sensors might be used for monitoring the climate. These are

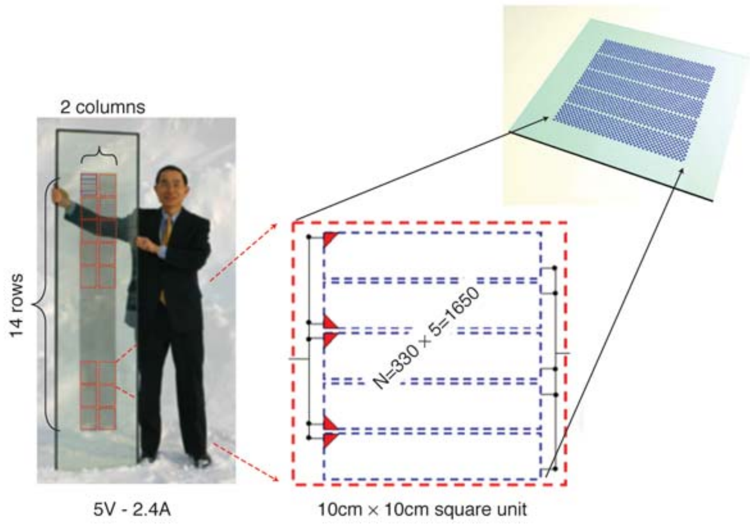


Fig. 3: Sphelar panel window for BIPV

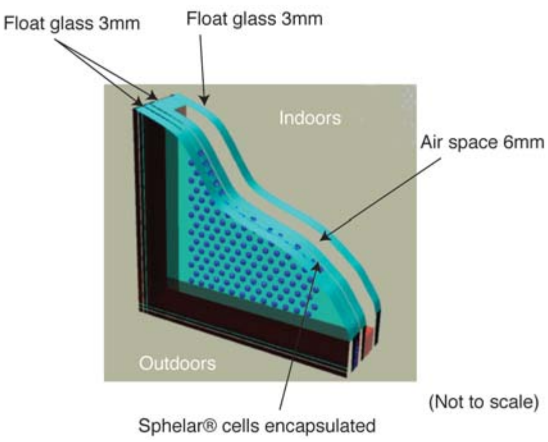
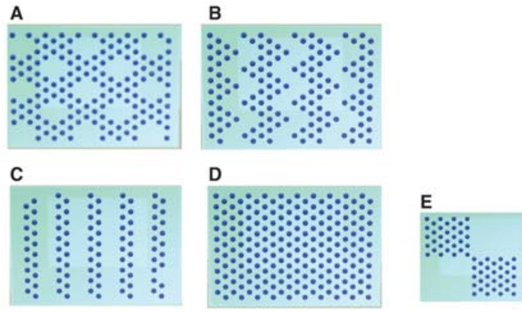


Fig. 4: Schematic drawing of Sphelar panel window

Kyosemi's scenarios for the deployment of Sphelar in the area of low-power-consuming applications.

Meanwhile, the potential role of Sphelar cells in building construction is exciting. Many people are trying to design sustainable buildings that use renewable energy as much as possible by making the most of the light and heat of the sun including direct, reflected and diffused light to obtain coolness, warmth and brightness. This is where transparent modules using Sphelar cells display their real ability. As Sphelar cells are about 1mm in diameter and allow all kinds of arrangements, they can be completely integrated with building materials used for exteriors, including window materials, facades, eaves and openings. Used as a transparent window material, Sphelar cells, due to their spherical shape, enables power generation no matter the position of the sun, which changes by the minute depending on the time and season. With these modules, conventional discussion of efficiency, that is, the method to divide output by the power of sunlight illuminated on the entire module, no longer makes sense. Rather, the performance should be measured in terms of electricity generated per day or annually. A prototype transparent panel is made by connecting 10cm.sq. units (Fig.3). Laminated glass with double-pane construction is used (Fig. 4). By including an air layer in the panel window, conduction of heat is reduced. Down the road, Kyosemi plans to accumulate basic data on the effect of the transmitted light on the brightness of a room, the effect of the panel window on blocking the heat of the sunlight and suppressing increases in room temperature in the summer, and the window's effect on retaining room heat in the winter (Fig. 5). Naturally, when the Sphelar panel is used in windows, output power declines with increasing transparency (decreasing cell density). To accommodate a variety of buildings in practical applications, designs with enhanced aesthetic features for respective levels of transparency are necessary, although it depends on required generation capacities (Fig. 6). In designing Sphelar patterns, consideration must be given to the interior and exterior designs of buildings, as well as to views seen through windows. As the solar cell modules are integrated into building materials, their prices and quality assurance need to be handled as part of the building materials, not independently as solar cell modules.

Lastly, at the point when the mass production system is fully in place, the ultimate application area will be as a supplier of large amounts of power. There, the cost benefits of Sphelar spherical solar cells will be fully delivered. Efficiencies can be further gained by collecting light through inexpensive lenses. Sphelar itself is structurally durable and recyclable. This feature of Sphelar will also be exploited. Through its Sphelar business, Kyosemi hopes to contribute to the construction of a new living space in the twenty-first century. ❑



Case	Packing density	Output (W/m^2)
A	19.0	21.5
B	16.5	18.8
C	13.1	15.0
D	27.5	31.0
E	11.1	13.1

Calculated

Fig. 6: Variety of patterns of Sphelars in window panel

About This Article

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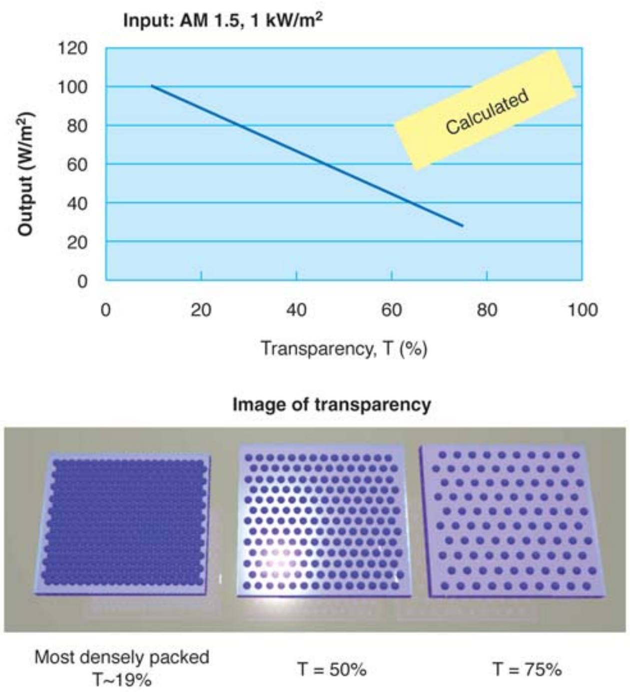

Fig. 5: Output power of Sphelar panel window vs. transparency