TRANSPARENT SOLAR PANELS

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ABSTRACT

This article is about Transparent Solar Panels. Discusses current and future applications of Transparent Solar Panels. Here the pros and cons of Transparent solar panels are discussed. The different characteristics of transparent solar panels from conventional solar panels are discussed in detail. The replacement of window panes with solar panels is being discussed in the construction industry. Most importantly, information is given on the wide application of all these in the near future. In addition, this article extensively mentions the pros and cons of transparent solar panels. The article notes that transparent solar panels produce less electricity than conventional solar panels. This article compares the production costs of transparent solar panels and conventional window glass and conventional solar panels. Obviously, transparent solar panels are more expensive than window glass, but transparent solar panels are cheaper than conventional solar panels. Currently, these solar panels are not widely used. Because it was discovered very recently, but all this cannot stop the development of transparent solar panels. My main purpose in writing this article is to explain to people the importance of this discovery.

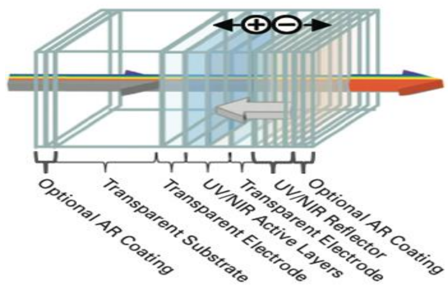
Keywords: solar panels, alternative energy, transparent electrode

INTRODUCTION

New solar panel technologies are set to transform the global solar energy landscape. Some of these promising technologies are already in the advanced stages of development, and could hit the market fairly soon. With these innovations, solar is no longer going to require extensive land parcels or unsightly roof spaces. (Aesthetically appealing and highly efficient solar shingles, for example, are already creating attractive solar roofs.)

Figure .1

What are transparent solar panels? Photovoltaic glass is probably the most cutting-new solar panel technology that promises to be a game-changer in expanding the scope of solar. These are transparent solar panels that can literally generate electricity from windows—in offices, homes, car's sunroof, or even smartphones (fig.1). Blinds are another part of a building's window that can generate electricity (we will discuss it in a later section). Researchers at Michigan State University (MSU) originally created the first fully transparent solar concentrator in 2014. This clear solar panel could turn virtually any glass sheet or window into a PV cell. By 2020, the researchers in the U.S. and Europe have already achieved full transparency for the solar glass. These transparent solar panels can be easily deployed in a variety of settings, ranging from skyscrapers with large windows to a mobile device such as a phone, a laptop, or an e-reader. As these solar power windows can simply replace the traditional glass windows in offices and homes, the technology holds the potential to virtually turn every building in the United States and the world into a solar producer. How do solar panel windows work? A transparent solar panel is essentially a counterintuitive idea because solar cells must absorb sunlight (photons) and convert them into power (electrons). When a solar glass is transparent, the sunlight will pass through the medium and



defeat the purpose of utilizing sunlight. However, this new solar panel technology is changing the way solar cells absorb light. The cell selectively harnesses a portion of the solar spectrum that is invisible to the naked eye, while allowing the normal visible light to pass through.

Figure .2 **Figure.3**

To achieve this technological wonder, the researchers have developed the transparent luminescent solar concentrator (TLSC) rather than trying to do the impossible by creating a transparent photovoltaic glass cell. The TLSC is composed of organic salts that are designed to absorb specific invisible UV and infrared light wavelengths, which then glow (luminesce) as another invisible wavelength (fig.2). This new wavelength is then guided to the edge of the window plastic, which thin PV solar cell strips convert it into electricity. Once the mass production begins for transparent solar panels, researchers estimate that the TLSC should be able to deliver an efficiency of about 10%. This may not appear to be an earth-shattering number, but on a national or global scale, when almost every window in a home or office building consists of clear solar panels, the results can be transformative. As the transparent solar panels cost comes down with their mass production and deployment, this non-intrusive technology can be scaled right from commercial and industrial applications to handheld consumer devices, while remaining very affordable.

Types of transparent solar panels: Just the way solar roof panels are currently produced using different technologies (Tesla's solar shingles and other technologies), solar windows are also being developed using different techniques. The two major types of transparent solar panels include partial and full transparent panels (fig. 3).

Partially transparent solar panels: A German manufacturer, Heliatek Gmb, has developed this partially clear solar panel, which can absorb about 60 percent of the sunlight it receives. Compared to the conventional solar PV cells, the partially transparent solar panels have a lower efficiency at 7.2%. However, solar power generation can be increased by adjusting the balance between the sunlight that is transmitted and absorbed. For instance, in south-facing glass buildings, it is often important to reduce the transmitted light (many such office buildings already use tinted glass). In these locations, the partially transparent solar panel can work very well.

Fully transparent solar panels: As described in the beginning of this report, researchers at MSU have already achieved a breakthrough to produce fully transparent photovoltaic glass panels that resemble regular glass. Researchers estimate the efficiency of these fully transparent solar panels to be as high as 10% once their commercial production commences. It's vital to understand here that when it comes to solar panel windows, efficiency of the panel is not the be all and end all. In practical terms, a less efficient solar window only means that the window has to be larger in size compared to the more efficient panel in order to generate the same amount of electricity. Once fully transparent solar panels get integrated into large windows in buildings, their lower efficiency is bound to be overcompensated by their potential scale of deployment.

Solar panel blinds: An easy-to-implement solar window technology. Solar panel blinds are a supplement to transparent solar glass/panels when using the window to generate electricity. Solar panels are designed to harvest sunlight to produce energy, while the essential function of window blinds is to block direct sun's rays from entering inside.

How important is solar panel efficiency?

The poor efficiency of transparent solar panels is certainly a negative – especially when you compare it to the best solar panels on the market – but it's not actually a major problem. If a building has limited space for traditional solar panels, then efficiency becomes a very important consideration. However, if you're replacing every window on the side of a building with a transparent solar panel, the individual performance of each panel becomes less of an issue. For example, a huge corporate building in the city centre might have 20 square metres of monocrystalline solar panels, each with 20% efficiency. If they replaced this with 40 square metres of transparent solar panels on an external wall, each with 10% efficiency, then the energy production would be the same, and the building's appearance would be vastly improved. We agree, it's a bit of a weird one. Generally speaking, the more transparent the solar panel, the worse its efficiency – but the more transparent the solar panel, the greater its number of potential uses.

Spectral response of conventional and transparent PV cells

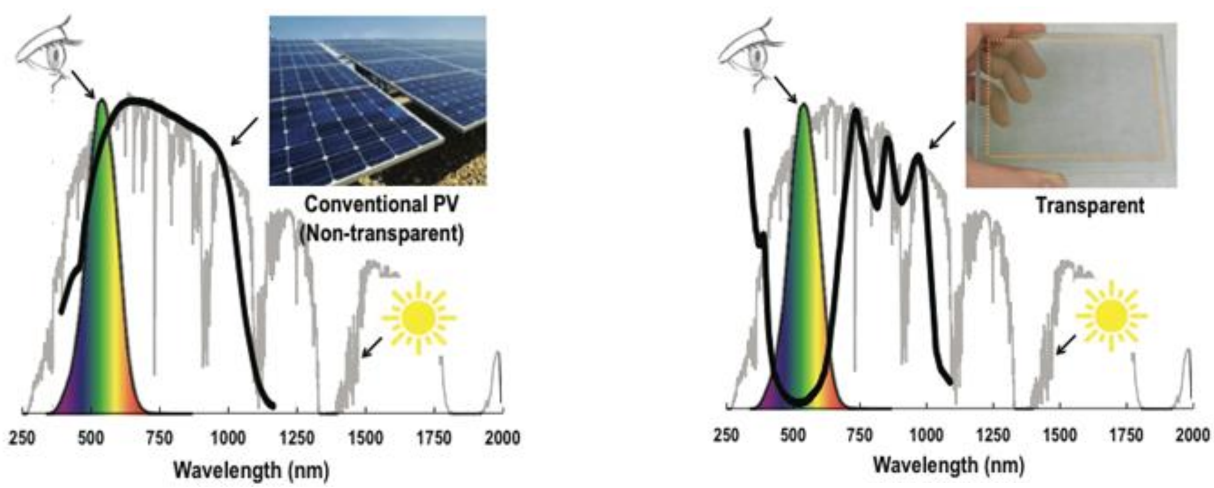


Figure 4.

That critically placed gap makes the MIT solar cell transparent to the human eye—but it also means that the cell does not capture all the incident energy. "We do let the visible photons [light particles] pass through, allowing them to efficiently light the room. But we try to catch all of the photons in the infrared and ultraviolet," says Bulović. "We try not to let any of those photons get through. So a honey bee—which sees in the ultraviolet—wouldn't think it's transparent, but we humans do." Current versions of the team's cells transmit more than 70% of the visible light, which is within the range of tinted glass now used in the windows of buildings. But their power-conversion efficiency is low—only about 2%. In a detailed theoretical analysis, Lunt, Bulović, and others showed that their design should realistically be able to reach over 12% efficiency, a rating comparable to that of existing commercial solar panels (fig.4). Getting there will be a challenge, but they believe they can do it by carefully optimizing the composition and configuration of the PV materials. Indeed, says Lunt, by simply "stacking" their transparent solar cells, they could potentially reach an efficiency of 10% while still maintaining the ability to transmit light. Already they have demonstrated that an array of transparent cells integrated in series can power the liquid crystal display on a small clock, relying entirely on ambient light. One remaining challenge is longevity. In commercial applications such as window coatings, the solar cells need to continue performing well for many decades. According to Bulović, work to extend the lifetime of related products, such as LEDs, has made good strides. With many industries tackling the same issue, he believes that this engineering problem should be solved in the coming years, and their solar cells should be guaranteed to have a commercially viable lifespan.

Costs and benefits: The cost of implementing the technology will vary with the application, solar cell efficiency, and other factors. But Barr cites several sources of potential cost savings over traditional solar systems. For instance, the processes used in fabricating the new transparent PVs are environmentally friendly and not energy intensive. Indeed, the coatings are deposited at nearly room temperature, so the transparent PV can be laid down on essentially any type of surface. There's no need to use glass, which is a costly component in the fabrication of conventional systems. Even more significant savings could come during installation—often a benefit of "piggybacking on existing infrastructure," says Barr. To illustrate, he refers to PV-coated window glass. During new construction or a window-replacement project, the PV coating could be added for very little extra cost. The coating could easily be deposited on one of the inner surfaces of double-paned windows, along with standard low-emittance or solar-control coatings. The PV layer would be encapsulated between the panes, well protected from weather, window washing, and other outside threats. More important, the glass, framing, and installation costs would be included in the overall cost of the construction project—the same with or without the PV coating. In contrast, when using a conventional PV system, those costs can make up half to two-thirds of the total. Distributing the energy generated by the PV-equipped windows could be as simple as placing a wire connection, power electronics, and an outlet at the side of each window or series of windows. The benefits from adding the solar cells should be significant. The windows in a skyscraper, for example, provide a vast vertical area directly exposed to the bright morning and early evening sunlight. In one analysis, the research team calculated that if all those windows contained the transparent solar cells—assuming just 5% efficiency—the power generated could fulfill more than a quarter of all the electricity needs of the building. Moreover, the solar cells would block much of the infrared radiation, a large part of the sunlight that heats up a room. That effect could cut down on air conditioning needs, further reducing energy use and operating costs in the building. And all of those benefits would be gained without modifying the look of the building or obstructing views for the occupants.

Getting it into the world: Recognizing the commercial potential of this technology, Barr, Lunt, Bulović, and Bart Howe co-founded a company called Ubiquitous Energy, a name that reflects their vision of PVs seamlessly deployed throughout our everyday life. They are continuing development work to optimize their transparent PVs, using different semiconductor materials and device configurations that will lead to higher efficiencies and better transparencies. And they are figuring out how to integrate the PVs into consumer products that will perform their usual functions and harvest energy at the same time.

Barr expects to have their first commercial products—for mobile electronic devices—ready within a few years. Enabling such devices to gather energy from ambient light and recharge their own batteries will provide significant benefits, including added convenience, greater freedom from the power grid, and a better user experience. Perhaps more important, in the process of developing products for mobile devices, the team will learn how to make larger energy-harvesting systems so that a few years later they can scale up their techniques to the size of windows.

The future of transparent solar technology: The potential to generate renewable, clean energy from the sun is enormous with transparent solar panels considering the number of skyscrapers and buildings already in existence or under construction with a massive amount of glass surface. According to Richard Lunt, the Johansen Crosby Endowed Associate Professor of Chemical Engineering and Materials Science at MSU, highly transparent solar cells represent the "wawe of the future" for new solar panel technologies. Lunt says that these clear solar panels have a similar power-generation potential as rooftop solar, along with additional applications to improve the efficiency of buildings, cars and mobile devices. Lunt and his team estimate that the U.S. alone has aboutabout5 to 7 billion square matters of grass surface at present. (Just in the last 10 years, as much as 682 million sq. ft. of office space has been added in the U.S.). With this much of glass surface to cover, transparent solar panel technology has the potential to meet about 40 percent of the country's annual energy demand. This potential is nearly the same as that of rooftop solar. When both these technologies are deployed complimentarily, it could help meet nearly 100 percent of the U.S. electricity needs if we also improve energy storage.

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