Black Solar Cells Have Lowest Reflectance for Silicon Solar Cells

Scientists at Natcore Technology Inc using simple liquid bath processes, have created a black surface on a silicon wafer with an average reflectance in the visible and near-infrared region of the solar spectrum of 0.3%, making it the "blackest" silicon solar cell surface ever recorded. Compared with standard production cells now available, this represents a tenfold reduction in reflectance over that portion of the spectrum, which is the source of about 80% of the usable power that can be drawn from sunlight.

The black colour of black silicon results from the near-total absence of reflected light from the porous wafer surface. With solar cells, "blackness" is highly desirable because it indicates that incident light is being absorbed for conversion to energy rather than being reflected and thus wasted. Quantitatively, reflectance is the proportion of light striking a surface that is reflected from it. Thus a reflectance of 0.3% means that only 0.3% of incident light is reflected from the solar cell's surface, while 99.7% of incident light is absorbed by the cell and is available for conversion into electrical energy. A tenfold reduction in reflectance would mean that up to 3% more usable light would get into the cell, effectively increasing the cell efficiency by that amount. (An 18% efficient cell becomes an 18.5% cell, for example.)

But there are additional benefits to be derived from black silicon. A panel made from black silicon solar cells will produce significantly more energy on a daily basis than will a panel made from cells using the industry standard antireflective coating. First, because it reflects less light. Second, because it performs better during the morning and afternoon hours when the sun hits at an angle. (It also outperforms standard cell panels on cloudy days.) Its higher energy output, combined with a lower cost using Natcore's patented process, could quickly make black silicon the global solar technology of choice.

Natcore's process began with an uncoated, textured silicon wafer that had an average reflectance of approximately 8%, giving it a mottled gray appearance. First, nanoscale pores were etched into the wafer surface by submerging it for a few minutes in a liquid solution at room temperature. Next, using the company's liquid

phase deposition (LPD) process, Natcore scientists filled the pores and then over-coated them with silicon dioxide. This combination step both coated and passivated, thereby allowing lower reflectance. After the surface treatments were completed, the wafers were taken to the State of Ohio's Photovoltaic Research and Development Center at the University of Toledo, where the reflectance was measured.

Conventional cells, with antireflective coatings made via a chemical vapor deposition process that requires a high-temperature vacuum furnace and hazardous gases, have a reflectance of about 4%. With black silicon, the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) lowered the number below 2%. Now Natcore's technology has reduced it to 0.3%, or virtually zero. "*Absolute black is to reflected light as absolute zero is to heat.*" says Dr. Dennis Flood, Natcore's Chief Technology Officer. "*And getting close to zero reflectance with a process that we can use for the production of commercial solar cells is simply astounding.*"

Natcore was recently granted an exclusive license by NREL to develop and commercialize a line of black silicon products based on NREL patents. Natcore's reflectance accomplishment came about as a natural part of its work associated with that license. "*We are already working with two equipment manufacturers to design a production tool,*" says Natcore President and CEO Chuck Provini. "*The tool would make 2,000 black silicon wafers per hour. We'll establish other parameters in our lab. When the design is completed, we'll take orders for the tool. We have already begun talking with potential customers in Italy, China and India.*"

William Farris, NREL's Vice President of Commercialization & Technology Transfer, says "*NREL has a long history of working with companies to move renewable energy technologies to the market. We're encouraged and gratified at Natcore's success as it relates to our commercial license agreement for NREL's black silicon technology.*"

Source: Natcore Technology Inc

Top image of black silicon solar cell: NREL

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