

Providing Technology that Immediately Improves the Performance and Cost of Products and Manufacturing Lines, Bandgap Engineering, Inc. will Remake the Industry with the Potential to Double the Efficiency of Solar Products

**Clean Technology
Solar Cell Design**

**Bandgap Engineering, Inc.
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**Richard Chleboski
CEO**

BIO: Richard joined Bandgap in December 2011 as its CEO. Prior to Bandgap, he co-founded Evergreen Solar and served in several senior management roles, including most recently its Chief Strategy Officer and Vice President of Strategy and Business Development, where he was responsible for the company's overall business strategy and its strategic partnerships. Before this role he was Evergreen's Vice President of World-

wide Expansion from January 2006 until December 2007 and the Company's Chief Financial Officer and Treasurer from its founding in August 1994 until January 2006. As CFO he managed all finance, accounting, budgeting and planning activities and raised approximately \$300 million from both public and private sources. Prior to founding Evergreen Solar, Richard worked at Mobil Solar Energy Corporation from 1987 - 1994. During his tenure, he worked as Mobil Solar's strategic planner and as a process engineer. Richard received a B.S. in Electrical Engineering from the Massachusetts Institute of Technology and an M.B.A. from Boston College.

About Bandgap Engineering, Inc.: Bandgap has pioneered the development of highly tunable and inexpensive methods for nanostructuring silicon and is applying this technology to high efficiency silicon-based photovoltaic cells and high capacity Li-ion batteries. Founded in 2007, the company is venture-backed by New Enterprise Associates, Presidio Ventures and the Massachusetts Green Energy Fund and is based in Woburn, MA. For more information, visit the Bandgap web site at www.bandgap.com.

**Interview conducted by:
Lynn Fosse, Senior Editor
CEOCFO Magazine**

CEOCFO: Mr. Chleboski, what attracted you to Bandgap Engineering?
Mr. Chleboski: Quite simply it is technology and team. On the former, Bandgap has developed a technology that can immediately improve the performance and cost of today's

products and manufacturing lines and in the longer-term remake the industry with the potential to double the efficiency of solar products. On the team, starting first with Bandgap's co-founder Dr. Marcie Black, we have assembled a tremendously talented and dedicated group of technologists who are now the recognized leaders in nanocrystalline silicon technology. What CEO would not want to lead an organization that has that kind of opportunity available to it?

CEOCFO: Would you explain how the technology works?

Mr. Chleboski: We use nanotechnology to make black silicon. Theoretically you want a solar cell to absorb any and all light that hits it to maximize its efficiency. In practice however, an untreated silicon wafer reflects about 20% of the light that hits it and a well-made solar cell reflects about 6%. Our nanowire solar cells can reduce this to about 1%. That added light absorption translates directly into increased power or efficiency of the solar cell. This enables us to make today's solar cells 5-7% more powerful than standard products and with lower costs. Our technology does this by nanotexturing a silicon wafer. Visually the cell looks black but at the nanoscale it is really billions of tiny silicon wires. This translates into more light into the cell and more power out.

CEOCFO: Why has that not been tried previously?

Mr. Chleboski: It has been, but it is practically very difficult to devise a technique that simultaneously has low reflections and high efficiencies.

Others have tried to develop similar technologies but they have not achieved the performance we have. That we've had this success is a credit to Bandgap's entire technical team.

CEOCFO: Is the technology being used today or is it still in a development setting?

Mr. Chleboski: We have demonstrated the performance benefits of the technology and are now beginning pilot production. Because the solar industry is suffering from over capacity, we have spent the past 12 months tuning our process to produce nanowire solar cells on existing production lines, lines that were not designed to use our technology. While this was quite a constraint for our technical team, and to some degree limits the performance we can obtain with our process, it provides a valuable and rapid commercial expansion path. We expect to successfully complete our pilot activities over the next several months and move to commercial production shortly thereafter.

CEOCFO: What has been the response so far?

Mr. Chleboski: The response has been tremendously positive. In any market, but particularly one as competitive as today's solar industry, existing manufacturers are always looking for ways to upgrade their existing production lines. We offer them a "drop-in" improvement that enables them to produce a new, premium product using their current production tools, staff and facilities. Opportunities of that sort are rare and consequently the response from these manufacturers, our commercialization partners, has been outstanding.

CEOCFO: Do people understand immediately how the technology works or is there a particular point where they understand it and know that it is viable?

Mr. Chleboski: They certainly understand the concept of how it works when we sit down and have a conversation. There is some skepticism about whether and how we

can be successful when others have failed. However, when we recently showed a performance benefit on a standard production line, that was an "aha" moment for a number of potential partners. To be sure there is still work to be done before they will introduce it into their full scale production lines, but the ability to see a performance boost using standard tools and processes changed the dynamic markedly.

CEOCFO: What is the timetable as you go forward? How are you going to continue on the commercialization process?

Mr. Chleboski: Our next step is to pick a couple commercialization partners to begin pilot manufacturing of our nanowire solar cells. The first step will be to transfer our technology to their pilot lines and replicate the performance we have already demonstrated. During pilot production

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we will address any manufacturing issues and also define the commercial relationship. I anticipate we will remain in pilot manufacturing for about six months before we move to commercial scale production.

CEOCFO: Are you funded for the oncoming steps?

Mr. Chleboski: Like most startups we are always evaluating additional sources of funding and we will need to raise additional funds to fully commercialize the technology. To date we have been venture capital funded and our lead investor is New Enterprise Associates. As we move forward we will look to augment our financing team and will explore funding from angle, venture, and strategic investors.

CEOCFO: Solar is somewhat out of favor these days. How do you break through that with investors?

Mr. Chleboski: It is challenging but like any good engineer we try to present it as an opportunity for the right investors. The key is that Bandgap offers technology that integrates with existing production lines and improves their performance. The solar industry has grown to the point where it is about a \$100 billion a year industry. If you have the ability, like Bandgap has, to create a significant improvement to an existing \$100 billion industry, that is very valuable. Couple that opportunity with our longer-term potential to fundamentally change the nature of the industry and you have a unique investment opportunity.

CEOCFO: What do you need to do or look at to obtain that greater efficiency? What is in the R&D process?

Mr. Chleboski: We divide our development programs into near, mid and longer-term time periods. Currently we are focused on moving our near-term, demonstrated technology into pilot and then commercial scale manufacturing. This is not R&D but rather development and engineering. The challenges

are not efficiency breakthroughs, but process refinement and consistency. Our mid-term development, looking out 2 to 3 years, is focused on having the best technology available for anyone building a new manufacturing line. In this timeframe we've removed the constraint that it must work in an existing production line and allowed our team to explore processes and technologies that are or soon will be ready for production. This will enable us to leverage developments around the world that are enhanced by our nanowire technology. And of course we have an ongoing effort on our longer-term technology. Here we are working to demonstrate how we can engineer silicon's properties to double solar cell efficiencies, that is make solar cells that convert 35 to 40% or more of the incident light into electricity, double today's 17-18% average. Success in this program will

enable us to change the very nature of the solar industry.

CEOCFO: Why should people in the business and investment community pay attention to Bandgap Engineering?

Mr. Chleboski: We are one of the few companies in the solar space that has an exciting and profitable market opportunity right now and has the longer-term potential to remake the industry. Having been in the solar

business for 25 years myself, I can confidently say there are not a lot of companies that offer that kind of opportunity and Bandgap is one of the few that does.



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