Silicone under the spotlight

Because they can withstand extreme environmental conditions, silicones are ideal for solar panel and photovoltaic (PV) applications. And while solar cells themselves are made of silicon, silicones are used during module assembly and installation as encapsulants, coatings, potting agents, adhesives and sealants. We present an overview and an interview, courtesy of Dow Corning.

Dow Corning’s latest PV-5802 Electrically Conductive Adhesive is a high performance and reliable silicone-based ECA for back contact PV modules, which helps increase long term sustainability and reduces the overall cost. This material technology can potentially be applied beyond back contact modules and bring benefits to our customers for other type of modules.

Dr. Guy Beaucarne, Senior Application Engineer, will present a poster at the upcoming EUPVSEC event and will show the results of the study made with ECA interconnection and conductive backsheet on back-contact Metal Wrap Through (MWT) Modules. The study will look more specifically at the performance and reliability through material testing, accelerated aging and field testing.

The silicone advantage
• Silicones are renowned for their UV stability and moisture resistance
• Silicones are durable and solar radiation resistant
• Silicones have low ionic impurities, low moisture absorption and a low dielectric constant
• Silicone encapsulants perform over a wide operating temperature range – from -40 to 150°C (-40 to 302°F)
• Silicones are optically transparent over a wide spectrum
• Silicones offer excellent adhesion to glass and photovoltaic cell substrates
• Optical, mechanical and thermal properties can be varied to meet the requirements of specific photovoltaic applications

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Dow Corning is a trusted technology partner to solar businesses across the value chain and one of the few companies in the world to provide silicon-based solutions throughout the entire photovoltaic value chain.
Ask the experts

We grabbed five minutes with Dr. Guy Beaucarne ahead of his EUPVSEC presentation...

PES: This is the first time we’ve spoken to you, Dr. Beaucarne, can you tell us about your particular area of expertise?

Dr. Guy Beaucarne: I received my Master’s degree in Engineering in 1995 and PhD Degree in 2000, both from the Catholic University of Leuven (KUL), Belgium. The focus of my Ph.D. research at IMEC, Belgium, was in the field of thin-film silicon solar cells. After my PhD, I spent some time in Sydney, Australia, first as post-doc at the University of New South Wales (UNSW), and then in a solar start-up called Pacific Solar.

In 2003, I returned to IMEC and became Group Leader of the Solar Cell Technology group. I developed a particular interest in metallization technology and started with other experts a series of Metalization Workshops that take place every one and a half year. I joined Dow Corning in 2009 and have a R&D role in new materials and processes for the solar cell and module manufacturing industry. Although my initial research topics were mostly on materials for solar cell manufacturing, I mostly focus on materials for module manufacturing.

PES: We’re interested in hearing a little more about the features and advantages of Dow Corning’s latest PV-5802 Electrically Conductive Adhesive...

GB: Most ECAs are based on organic polymers, such as epoxy or acrylic materials. In contrast, PV-5802 is a silicone-based ECA, which gives it very different properties. Organic ECAs are often very stiff at low temperatures and become softer at high temperature. The glass transition temperature of their polymer lies in the middle of the operating temperature range of PV modules. This is not good for joint reliability. Going to low temperatures, there is large differential contraction, which causes, in case of a stiff joint material, large forces and possible joint failure.

In comparison, PV-5802 is a soft material and has almost constant mechanical properties throughout the operating temperature range. The flexibility of the material allows some relative movement between the cell and the interconnector material leading to lower stress and lower probability of failure.

This enhanced joint reliability results in enhanced module durability and reliability. Numerous tests, internal and external, on mini- and full size modules, have confirmed that. As a result, we have observed that module manufacturers who care about module reliability and durability tend to select PV-5802 above other ECAs.

PES: Can you talk us through your recent studies made with ECA interconnection and conductive backsheet on back-contact Metal Wrap Through (MWT) Modules?

GB: MWT modules based on ECA and conductive backsheets (CBS) are very attractive for module assembly because it potentially can increase efficiency substantially, enhances module appearance and enables fully automated module assembly. We developed PV-5802 specifically for that technology in collaboration with Dutch research centre ECN, which has championed and developed this module technology for a long time. Furthermore we worked with equipment partners who are key in the adoption of new technologies. With conductive backsheet suppliers, we checked the contact resistance and adhesion of PV-5802 to their backsheets and found that we had low contact resistance and low Cell-to-Module loss with many types of CBS.

Recently, we have worked with several customers to test and qualify PV-5802 in MWT modules. With one of them, we pushed the accelerated aging tests to three times the IEC standards requirements in terms of damp heat conditions and thermal cycling, and the modules still passed the requirement of less than 5 % degradation. This is the type of data that is needed to convince potential adopters of the technology that they are not taking an excessive risk even though the technology is so different.

PES: What kind of testing is done in the field to ensure performance reliability?

GB: When testing a module technology, one relies on accelerated ageing tests such as those prescribed by the IEC standards (e.g. damp heat, thermal cycling, humidity freeze, etc.). However, there is a consensus among PV module reliability experts that those standards, while useful to avoid immediate failure and mediocre quality products, do not give prediction of the performance of the modules in operation and of their lifetime. Extended accelerated aging help a little to assess reliability better, but only to a limited extent.

Therefore, it is needed, in addition to extended accelerated aging tests, to install a large number of the new modules in a test field and monitor the performance (energy yield) throughout the day, through the months, and through a whole year. Only then can one start having a picture of how the modules will perform over the years. It is not yet a complete picture, which would require two decades of field testing, but one can have much more confidence already about the long term behaviour of a particular type of modules.

About a year ago, a field trial was started by equipment manufacturer and technology provider Valoe in Finland using back-contact MWT modules that included PV-5802 for the ECA. The data confirmed the outcome of accelerated aging, and showed strong and reliable outdoor performance. The results of this study will be presented in a joint contribution at EUPVSEC in Hamburg in September.

PES: What’s the biggest technical challenge that you’re currently presented with? And how are you working to meet this challenge?

GB: Concerning PV-5802, we received quite a few enquiries for applying it in traditional ribbon-based interconnection, including a traditional stringing process that requires extremely fast bonding of the ribbons. However, the material was not developed for such a process. Moreover, equipment for traditional stringing is generally not suitable for ECA use and requires modification.

What we are doing now is assessing in collaboration with potential customers to what extent the process can be adapted while PV-5802 still provides the key advantages that we observe in back-contact module assembly.

Generally, we see a lot of concern in the industry about reliability problems related to years of excessive focus on cost reduction and insufficient attention to quality and durability. In that context, we believe that Dow Corning, along with other high quality materials providers, can help provide solutions and restore confidence. Silicones offer proven performance and reliability, and opportunities for safe module innovations.

PES: Conversely, what area of your work gives you the most satisfaction right now?

GB: What gives me the most satisfaction is to see module manufacturers starting to use the innovative materials that we have been developing and promoting for a few years, now in their manufacturing lines, such as PV silicone encapsulants (Dow Corning PV-6212 Cell Encapsulant), conductive adhesive technology (Dow Corning PV-5802 Electrically Conductive adhesive) or silicone bonding technology (Dow Corning PV-6301 Fast Cure Sealant).

Reaching this stage was difficult because during the crisis years, cost pressure was huge and reluctance to change anything to module manufacturing was even stronger than usual. However, I believe that we have pushed the ball over the hill and that the adoption of these intrinsically better ways of producing modules can only gain momentum from now on.