

# Using Adhesives as a Means to Reduce Costs and Increase Performance in the Production of Photovoltaic Electricity

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**Abstract:** Although adhesives have been used for many years to manufacture cars in more efficient ways, their potential has not yet been fully exploited by the renewable energy industry. We argue in this article that photovoltaic module manufacturers can save costs and differentiate from competition by careful selection and use of their bonding systems. Clever adhesives can enable new, more effective product designs and can play a major role in the longevity of the complete product.

**Keywords:** Adhesive · Backrail · Clamp · Elastic · Fast · Green strength · Photovoltaic · Silicone

Sika AG, Switzerland, is a globally active specialty chemicals company. Sika supplies the building and construction industry as well as manufacturing industries (automotive, bus, truck, rail, solar and wind power plants, façades). Sika is a leader in processing materials used in sealing, bonding, damping, reinforcing and protecting load-bearing structures. Sika's product lines feature high-quality concrete admixtures, specialty mortars, sealants and adhesives, damping and reinforcing materials, structural strengthening systems, industrial flooring as well as roofing and waterproofing systems.

Sika has been active in the renewables market for more than 15 years, supplying structural polyurethane adhesives to leading windmill manufacturers. Today, 20% of all wind turbine blades installed in this world are successfully bonded with a Sika adhesive. More recently, Sika has entered the solar market by supplying adhesives and sealants to the photovoltaic (PV), Solar Thermal, and the concentrated solar power (CSP) industry.

Global demand for renewable energies continued to rise during 2011 and 2012 and by year's end, 21.7% of all the global electricity was supplied from renewable sources. Wind power accounted for about 39% of renewable power capacity added in 2012, followed by solar accounting for approximately 26%.<sup>[1]</sup>

Energy prices, and particularly from PV sources, have declined up to 5–7% every year on average since 1998<sup>[2]</sup> due to economies of scale and technology advances, but also due to excess supply. Combined with the economic crisis, reduced subsidies and tensions in international trade, the environment for the equipment manufacturers has

never been so challenging and cost reductions along the value chain are the key to remaining competitive.

At Sika we believe that using the latest technologies of adhesives and adhesive application can help manufacturers to achieve the cost and quality targets they need to reach grid parity and open new market opportunities for renewable energies.

Even less than 40 years ago, adhesive connections were considered in engineering circles as being a second rate connection technology. They were used whenever “it wasn't important”. This is now history; modern adhesives can easily compete with mechanical connection technologies.<sup>[3]</sup>

Yet, the potential of adhesive bonding has not been exploited to the full in the PV industry, despite the fact that its use has increased steadily over recent years.

Adhesives and sealants have mostly been used in the PV industry to seal the gap between the frame and the module itself (Fig. 1). The frame is very effective at protecting the glass module; it is however a construction that can lead to micro cracks creation or even glass breakage. Stresses arise through wind and snow loads and are dissipated into the frame *via* the edges of the glass. At the transition between the bending glass and the rigid edges, however, stress peaks occur, and that is what leads to cracks in the glass or micro cracks in the cells. The same situation occurs on the edges of modules fixed by clamps as shown in Fig. 2.

Why does the solar industry need a frame around crystalline PV modules? Discarding the aluminum frame could save up to 5–7% of the material costs in the module and frameless modules offer a number of advantages to the module manufacturers, and their customers.



Fig. 1. Solar panel model showing a traditional frame construction.

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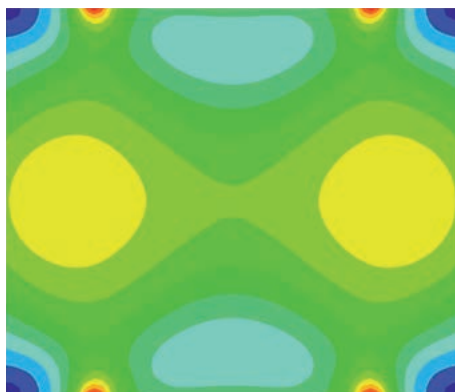


Fig. 2. Stress peaks created at the module edges by clamps.



Fig. 3. Backrails for fixation.



Fig. 4. Bonded backrails dissipate stresses along the bond line.



Fig. 5. Mounting pad bonded on the back of a glass model.

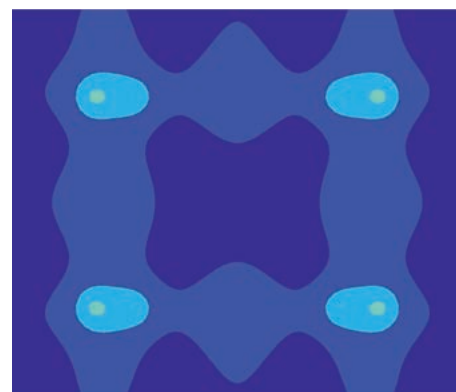


Fig. 6. Bonded mounting pads avoid critical stress concentration areas.

A logical and natural alternative to frames are backrails (Fig. 3) as they produce fewer stresses in the module, thereby reducing the risk of micro cracks (Fig. 4). They also reduce the complexity of production as there is naturally no need to press the module into a frame and likewise no seals to worry about.<sup>[4]</sup>

Bonding by other fixation means such as mounting pads (Fig. 5 and 6) offer, on top of these benefits, significantly reduced installation times compared to traditional clamps and screws.

However, module manufacturers have always had problems to select a good bonding system as there were, until recently, no ideal alternatives. Using a double-sided tape addressed the need for fast production speeds and fast processing of the finished modules after production, but could not compensate enough the surface unevenness of the large modules and long backrails. For these reasons, manufacturers also used high-performance and super-fast curing two-component silicone adhesives in order to run a fast production process. Having a super-fast curing adhesive unfortunately also comes at an expense; classical systems can be made so reactive that they effectively can hold assembled parts enough to continue processing them within minutes, but the working window left be-

tween adhesive application and bonding the parts becomes so tight that there is no room for unplanned stops of the line. Any

event forcing a line stop results in loss of material as the mixer full of adhesive must be either flushed, or changed regularly. To prevent this happening, it is a common practice to use 'only' a fast speed adhesive and fix pads of double sided tape next to the adhesive bead to hold the assembly together temporarily until the adhesive cures enough to make a durable bond. For a better understanding of process speeds with various systems, refer to Table 1.

Table 1. Process parameters based on adhesive curing speed (all values given were measured at 23 °C /50% r.h.)

Product	Mixer Open Time <sup>a</sup>	Maximum time between application and joining parts <sup>b</sup>	Minimum time between joining parts and moving the finished product to further steps <sup>c</sup>
Sikasil® AS-770	4–7 min	20 min	Days
Sikasil® AS-785	2–3 min	5 min	Minutes
Sikasil® AS-785 + adhesive tape	2–3 min	5 min	Immediate
Sikasil® AS-790	Approx. 1 min	2 min	Minutes
Sikasil® AS-780	2–3 min	5 min	Immediate

<sup>a</sup>Mixer Open Time means the time the material can remain in the mixer without flushing or extrusion of product; <sup>b</sup>also sometimes described as 'open time'; <sup>c</sup>does not correlate with curing time, as Sikasil® AS-780 holds parts initially together thanks to its physical properties.

Sika heard what our customers were telling us: they wanted a bonding system capable of holding small and big parts together instantly, allowing room for unplanned events on their lines, and not requiring additional pre- or temporarily fixation means nor complicated long conveyor belt systems. Our research teams, building on our long-term experience with automotive manufacturers, delivered last year a product that is doing just that.

Sikasil® AS-780 is a fast curing, high-performance two-component silicone adhesive meeting EOTA ETAG 002 and IEC

61646/61215 requirements. Its unique properties allow modules to be stacked after just two minutes, although the working time is at least twice as long as with a super-fast curing adhesive like Sikasil® AS-790 (see Table 1).

We believe this is the way adhesive manufacturers can help the solar and other renewable energy industries overcome the current challenges as such innovations can contribute to improve the longevity of the solar installations, while manufacturing and installation costs can be reduced.

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