

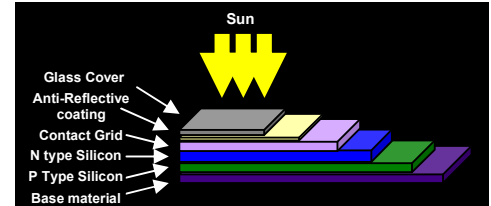
Technical Application Report



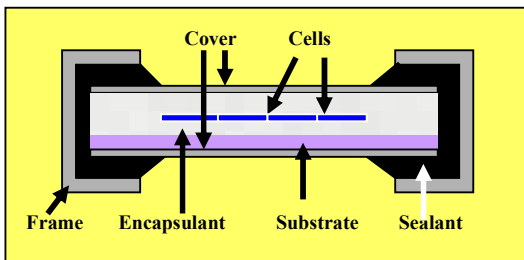
Photovoltaic Applications



Demands for greener forms of energy are driving the increase in solar panel manufacture for industrial and consumer applications. Silicones are used for several applications during the manufacturing process of the PV (photovoltaic) modules. The basic PV cell is constructed using layers of material sandwiched together as shown on the right. Electricity is generated when photons of light strike the semiconductor made of N and P type silicon. In order to provide suitable voltages and outputs for different applications, solar cells are connected together to form larger units. Cells connected in series have a higher voltage while those connected in parallel produce more current. These units are known as PV modules.



PV Modules



The interconnected solar cells are usually embedded in transparent ethylene vinyl acetate, fitted with an aluminum or stainless steel frame and covered with transparent glass on the front side to make a solar module. Silicones can be used in two applications during the manufacturing process:

- 1) Sealing the cell into the frame
- 2) As an alternative encapsulant to ethylene vinyl acetate

Bonding and Sealing

P V cells made from laminated glass or high performance plastics have to be bonded into aluminium housings before mounting into position. A high grade industrial silicone adhesive is normally used to make a strong yet flexible bond between the two surfaces. Silicone adhesives have for many years been used in similar applications throughout the building and construction industry. They are now proven to withstand the continual changes in temperature caused by the heating up and cooling down of exposure to sunlight. As the two materials have different coefficients of expansion, the flexible nature of the cured silicone will absorb the movements without causing stress to the cell. Resistance to the detrimental effects of UV light is another reason to use a silicone adhesive.

Although some choose to use the traditional Acetoxy grade silicone sealants, this is not recommended due to the corrosive nature of the acetic acid by-products given off during the curing process. Many other building grade sealants use Oxime cured silicones as they are considered to be a very low corrosive material; they do however, carry some health and safety issues.

ACC Silicones have developed a new generation of Acetone and Alkoxy cure industrial/electronic grade silicone sealants which can provide several benefits in this application:

- Neutral Cure - no corrosive by-products
- High Strength – suitable for large heavy cells
- Fast Curing – improves production times
- Excellent Adhesion – provides excellent bond strength
- No H&S issues

ACC Silicone Adhesive Sealants

Product Code	Description	Cure Type	Colour
PV5700	1-Part RTV adhesive sealant	Alkoxy	White
PV5701	1-Part RTV adhesive sealant	Alkoxy	Black
PV5702	1-Part RTV adhesive sealant	Alkoxy	Translucent

In addition to the above selection specifically targeted for use in PV, ACC Silicones manufacture a wide range of adhesives for use in electronics and other industrial applications suitable for high temperature resistance, thermal transfer and many more.

PV Cell Encapsulation

A polymer widely used as an encapsulant between the glass cover of a solar module and the glass cover of the solar cells within the module is Ethylene Vinyl Acetate (EVA). EVA is chosen for its hard-wearing, transparency, corrosion resistance and flame retardant properties.

Problems arise however, from the vacuum lamination process involved in sandwiching the EVA between the two sheets of glass. The disadvantages of this technology are high weight and the gap between the glass sheets at the edges, where moisture and gas can enter the photoactive layers and cause degradation. The process can't be easily automated and takes a lot of time, energy and material.

Recent investigations into the way light is transmitted through the encapsulant have shown distinct performance advantages of Silicone over EVA.

As an alternative to EVA, optically clear silicone encapsulant offers the following properties:

- Wide operating temperature range
- Excellent light transmission
- Repairable
- UV Stable and weather resistant
- Flexibility
- Easy to use

Electrical Protection

The sensitive electronics that are needed to control the output of the cell normally require some degree of protection from adverse environmental conditions. The most effective way to provide this protection for long term stability is to encapsulate or pot all the electronics within their housing. This will ensure complete protection against water or moisture ingress and resulting risk of short circuits or damage to PCB's and their components. Due to the nature of silicone chemistry it is possible to produce a wide range of encapsulating materials with variations in colour, hardness, cure speeds and adhesion.

Very soft silicone gels are chosen to provide a material that will accommodate extreme movement without inducing stress and also, facilitate the removal for repair or replacement of components should it be required. Harder materials will provide a more robust solid encapsulation.

Heat Dissipation

When one or more of the cells are shaded they will no longer produce power but consume it. To prevent this from happening by-pass diodes are connected to each of the PV cells within the module. These diodes will now produce heat which will need to be dissipated. By-pass diodes are often located within the control box. Silicone encapsulants can be loaded with thermally conductive fillers enabling them to conduct heat in addition to providing environmental protection.

ACC Silicones Encapsulants

Product	Description	Properties	Temp °C	Colour
PV2218	10:1 Silicone encapsulant	UV resistant non-yellowing	-60°C to + 200°C	Clear
PV2300	1:1 Silicone gel	Soft resilient gel	-55°C to + 200°C	Clear
PV2553	1:1 Potting compound	Thermally conductive	-50°C to + 260°C	Grey

In addition to the above selection specifically targeted for use in PV, ACC Silicones manufacture a wide range of encapsulants for use in electronics and other industrial applications suitable with high temperature, thermal transfer and many more.

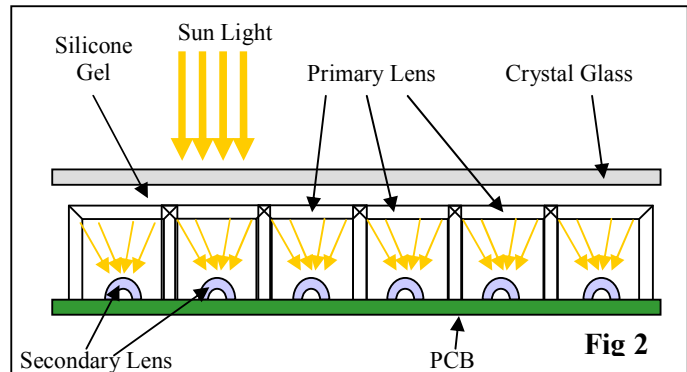
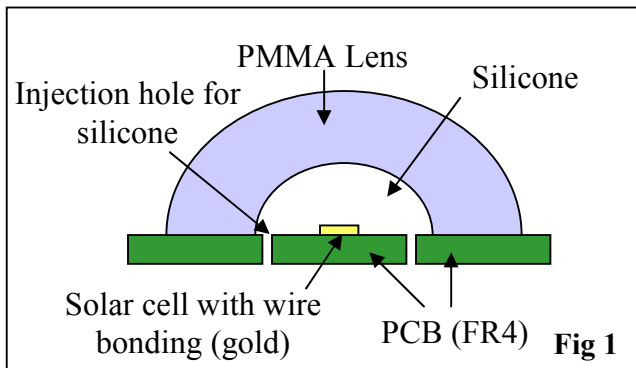
Concentrator PV Cells

New technologies are being developed to increase the performance and power output of PV modules. One such technology uses a series of primary lenses to focus the sun light onto individual PV cells.

Silicone encapsulants are used to protect the cell on two levels.

Fig 1 Shows each individual cell potted with silicone typically QSi1 216.

Fig 2 Shows the completed solar panel with a layer of Silicone Gel between the glass crystal and the bank of solar cells. The silicone offers protection and improves light transmission due to the refractive index of the silicone.



Approvals

ACC have obtained UL94 V-0 approval for many of their encapsulants. Please see product data for more specific information regarding approvals and testing.