

# DSM enables safer connections for Smart Homes

DSM has an extended portfolio of engineering thermoplastics for electrical and electronic wire-to-wire and wire-to-board connectors. It has numerous solutions for power, signal, and data transmission. Increasingly, these materials are being called upon for use in domestic appliances, and DSM is responding by expanding the portfolio with materials specifically formulated for these applications.

We live in an increasingly connected world. Not so long ago, if we wanted to communicate over long distances, we had little more available to us than the phone in our home and office, hard-wired to a network. Now, many of those phones don't exist anymore and our means of communication has multiplied enormously, thanks to wireless technologies. And we don't just talk to each other – everything is connected: people, cars, machines, and appliances. We have the Internet, the Internet of Things, the Industrial Internet of Things, and the Internet of Everything.

The connected home and the 'smart' grid are driving a transformation of the electrical goods industry. This extraordinary level of connectivity depends on many things, but one of the most elementary things of all is... the simple connector.

Consumers may have virtual connections to their smart appliances, but the appliances themselves still need real, physical electrical and electronic connectors. Designed poorly, these connectors can increase the risk of electrical failure, with potentially serious consequences.

Electronic connectors are of course commonplace in computers, portable devices, televisions and the like. But as our homes becoming more intelligent every day, there is a growing need for connectors in once mundane appliances like the refrigerator, the oven, the dishwasher, the washing machine, the air conditioning, the coffee maker – even the kitchen scales are taking on intelligence to guide you through cooking recipes. By 2020, the global value of the smart

appliance market is projected to be \$40 billion USD, and there will be close to 30 billion connected end-point devices around the world.

The connector is no longer simple at all. It's often an elaborate component transmitting data, signals, and power. It's an incredible combination of metal conductors and plastics insulation from which designers continue to demand more: more performance, more reliability, and more ease of use. The only thing they want less of in a connector is the size.

Home appliances are increasingly complex electromechanical systems with sophisticated user interfaces and control systems, and the addition of new functionality is a crucial design driver. There is however concern about the safety of appliances that can be switched on and operated without any direct human supervision. There have already been numerous reports of malfunctioning smart appliances catching fire with no-one around in the house to extinguish them.

As appliances become smarter and are left unattended more often to carry out ever-more complex tasks, needs for safety and reliability are increasing. There is a growing need for plastics for connectors with increasingly higher performance in terms of such properties as electrical resistance and flame retardance, as well as flow (to facilitate high speed production of parts with very thin walls and complicated geometries), heat resistance (to withstand assembly processes like reflow soldering for example), resistance to household chemicals... the list goes on.

## Challenges in connected home devices

The challenge from Appliance producers and connector manufacturers is to produce one product that will satisfy all regional regulations.

In the North American market, products must meet UL Flame requirements of Vo at the thinnest wall sections of the parts. While in the EU, it must meet GWT requirements on parts of 750°C min and increasing to 850°C with no flame. And in some Asian countries there may be a higher requirement than elsewhere for materials with a high comparative tracking index, or CTI. All regions call out a CTI requirement of 250V, however, individual manufactures are requesting CTI ratings up to 400V.

DSM is coming to the aid of appliance connector designers with advanced engineering plastics. DSM was the first plastics producer to offer thermoplastics for appliance connectors that meet the highest flame resistance requirements of standards organizations all around the world and which also have the required electrical properties.

In close cooperation with leading OEMs and connector manufacturers, DSMs innovation focus has succeeded in developing several materials that achieve the highest UL 94 flammability rating, V-0, at a thickness of just 0.4 mm, which also enables end products to pass the IEC 60695-2-11 Glow Wire Test (GWT) (sometimes also known as the GWEPT, Glow Wire End Product Test) without igniting at 850°C, and which also have a high CTI equal or above 400V.

DSM already has several advanced compounds based on polyamide 6 (PA6) and is now globally launching its Akulon® SafeConnect PA66 portfolio to meet increased safety and reliability requirements. For the first time, the new Akulon SafeConnect compounds are delivering the combination of UL flammability rating at 0.4mm, highest glow wire performance on end products together with a high CTI.

This material innovation is enabling connectors to perform at the highest safety levels that meet the most stringent requirements of smart appliance product designers. DSM is also increasing its offering in materials with high stiffness and extreme dimensional stability due to a change from petrol oil based feedstock to castor bean based renewable feedstock (EcoPaXX® family of PA410 materials).

DSM now has the largest portfolio of polyamides that not only enable OEMs to meet the IEC 60335-1 international standard on unattended appliances, but also meet individual OEM requirements that go beyond international standards to facilitate the need for increased safety and reliability of smart unattended appliances. This table shows key properties of Akulon SafeConnect SC21/SC22/SC41 as being listed on the UL Yellow Card.

## Appliance makers want more

Appliance makers around the world are raising their requirements for connectors. For example, Arçelik, headquartered in Turkey and one of the most important producers of white goods in Europe and Asia, requires a GWT performance on the part at 850°C – no flame. While Samsung has targeted the same requirement of GWIT on parts in recent years. Due to miniaturization, the distance between metal contacts is also reducing and more and more appliance makers are requesting the CTI requirement go up to 400 Volts. It also reduces wall thickness between terminal cavities, making it more difficult to meet both GWT and UL Flame requirements every time. These requirements are based on field experience to enable highest safety standards.

Because the test methods used to assess burning behaviours are very different, it cannot be assumed that a material obtaining the highest classification under one method will obtain a similarly high classification under another. Just consider: in the UL 94 test, samples are exposed to a naked flame, while the glow wire test uses no flame, but an extremely hot wire. This is one reason connector manufacturers have been forced to use different compounds for different markets.

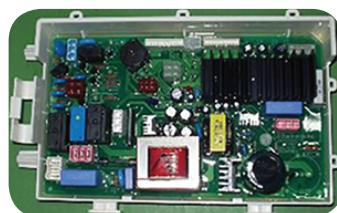
	Akulon® SafeConnect SC21	Akulon® SafeConnect SC22	Akulon® SafeConnect SC41	EcoPaxx® Under development
Filler Content	Unfilled	GF 25	Unfilled	Unfilled
GWIT	960 °C (0.4 mm)	875 °C (0.4 mm)	960 °C (0.4 mm)	
V-0	0.4 mm	0.4 mm	0.4 mm	0.4 mm
CTI	250 V (IEC 60112)	300V (IEC 60112)	450V (IEC 60112)	600V (IEC 60112)
RTI Electric	Under test	140 °C (0.4 mm)	Under test	

## Meeting tracking index requirements is crucial

Particles, moisture, and various liquids may contaminate the electrical and electronics components, providing a conductive bridge, for example, between two conductors mounted on an insulating plastics base. CTI is related to the creepage distance. Higher CTI materials provide easier and faster designs, and with less material needed, it means cheaper tooling and a faster time to market. How much does CTI matter? As the illustration below shows, with a printed circuit board (PCB) that has a protective box around it, the CTI required by the OEM for the connectors can be much lower than in a design where the PCB has no protection around it.

### Connector Material CTI

250V	≥400V
<ul style="list-style-type: none"> <li>• Housing unit required</li> <li>• Increased tracking distance</li> <li>• Higher production cost</li> </ul>	<ul style="list-style-type: none"> <li>• Housing unit not required</li> <li>• Decreased tracking distance</li> <li>• Lower production cost</li> </ul>

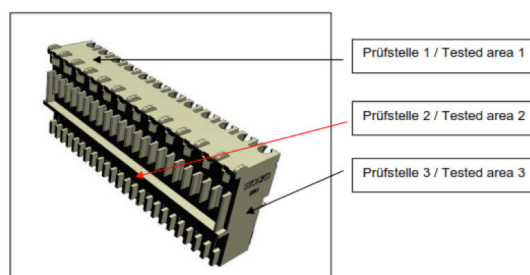
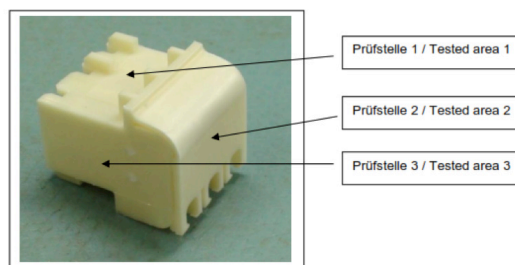


### Going beyond the standards

DSM has carried out numerous trials on its Akulon SafeConnect with customers in Europe and North America. One of the major producers of connectors and terminal blocks for appliances, Germany-based Stocko, has carried out an extensive analysis of DSM's Akulon SafeConnect SC41 in two different connectors.

Glow wire testing is normally carried out on plaques, and the results obtained does seldom correlate with the performance of actual connectors, where wall thicknesses and geometry are not the same throughout the part. This is what makes it so impressive when a real-life connector is tested at so many different points, with the wire put in at different angles, in different directions, and it always passes the test. This is what the customer and finally end-user really wants.

The Stocko tests were very comprehensive, testing the actual connectors at three different points on their surfaces (see photos). Stocko carried out glow wire tests at 750, 850, 900 and 960°C



Glow wire requirements for home appliances are specified in IEC 60335-1. However, the actual glow wire test methodology is covered in the IEC 60695-2 series of specifications. According to IEC 60695-2-11, for a part to pass the test, there must be no flame, or the flame must extinguish after no more than 30 seconds. These criteria were met by Akulon SafeConnect SC41 up to GWT 900°C -no-flame.

### Conclusion

With the increasing penetration of the Smart Home devices, DSM has developed compounds based on polyamides 66 and 410 specifically for connectors used in appliance devices globally. Akulon SafeConnect grades have a combination of industry-leading polymer and compounding technologies and expertise. DSM continues to work on further developments with PA66 and PA410-based products.

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