

# Structural Integrity

Pultrusion Product Guide



# Structural Integrity

**Constructions and assemblies operating in demanding environments need to maintain their integrity and functional performance over a prolonged period of time.**

**That is why engineering companies, architects and manufacturers of structural parts are choosing to use composite profiles and components for their designs. These components can be easily manufactured through pultrusion processes and assembled into structures that are stiff and strong, while they do resist the toughest environments.**

## **Performance that lasts**

Traditionally industrial installations like chemical processing plants and offshore platforms were constructed with steel profiles and gratings. Yet painted steel is not resisting well corrosive chemicals and seawater, so increasingly composite profiles are being used. Engineers know that composite structures can better survive harsh conditions, resulting in continued process safety and minimized maintenance cost. Moreover, installing these lightweight materials is easy and requires lighter equipment.

## **Customized shape**

Architects want to design a unique building that is aesthetically pleasing, while it is providing the right functionality and comfort to the final user. Composite profiles and panels have the capability to be manufactured in unique shapes. Combined with

the inherent thermal insulation and their high mechanical strength, composites enable creating a great and energy-efficient living environment. Consequently, both for commercial and residential construction composite materials are becoming increasingly popular.

## **Strength and stiffness**

Manufacturers of large parts like windmill blades, boats, public transportation vehicles, and cable assemblies often require composite components to provide additional structural integrity. Here again, weight savings, dimensional stability, low thermal expansion, and the benefit of integrating multiple functions into one make composites an ideal choice for continued performance.

# AOC. Trusted Solutions

## Environmentally sound

In many cases solutions based on composite materials provide a substantial reduction in carbon and/or Eco-footprint. Composite benefits like ease of part manufacturing, low maintenance, and light weight during use or installation greatly contribute to this result. It has been demonstrated that composites can be easily recycled through co-processing in cement manufacturing, representing a sound end-of-life solution at the end of a life of great performance.



# Performance & Innovation



Industrial scale production of pultrusion profiles and panels (courtesy Fiberline Composites)

Continued operation and minimized maintenance.

Cooling tower (courtesy Fiberline Composites)



Surface cladding for renovation existing buildings: Coathouse, Kolding (courtesy Fiberline Composites)



Approach lighting system  
Schiphol Amsterdam airport  
(courtesy Exel Composites)



Copper wire embedded in  
carbon fiber reinforced pultruded  
rods for use in Offshore  
(courtesy Vello Nordic AS)



Sorig® Glide sliding door from Alu-System, manufactured from slim and high strength composite profiles  
(courtesy Alusystems and Fiberline Composites)



# AOC Expertise

## Delivering Innovation

AOC experts will help you push the limits of part performance and component manufacturing. Together we will work together to literally shape our world with products that are lighter, stronger, versatile and more competitive.

AOC takes an integral approach to new product development, using our full expertise in polymer science, manufacturing, testing and component manufacturing. Industry specialists at AOC's R&D centers around the world support customers with state-of-the-art equipment, including resin synthesis, mechanical property testing capabilities and analytical testing laboratories.

Our scientists are continuously working on new solutions to help you be more competitive today. And, they are creating the innovation to drive your success in the future.

## Quality

You need consistent and reliable materials that you can trust, day after day. Your customers are counting on you. AOC produces the highest quality and most consistent products in the industry. Manufacturing expertise, proprietary equipment and automated process operation systems provide you with the consistency you can trust. AOC delivers the products you need and brings peace of mind so you can focus on your business and your customers.

## Your trusted partners

The AOC team is dedicated to finding the right solutions to help drive your success. We understand your business and will work together to determine how AOC products and service can help optimize your part performance and meet your customers' requirements. AOC experienced professionals are experts in both product performance and manufacturing processes.



From our polymer scientists, manufacturing, technical service and sales experts, the AOC team will be a true partner for your business.

**A world of experience**

AOC's foundation began more than 60 years ago. Through the decades, AOC has been focused on creating innovation, producing quality, and developing the type of partnerships that have helped our customers

grow their businesses and expand their markets. With facilities and global experts around the world, AOC is ready to work with you to find the solutions you can trust.

Previously serving the market under the names Aliancys, AOC Aliancys, and DSM Composite Resins, AOC has transformed the industry and has earned the position of the leading global supplier.





# AOC Key Products for Pultrusion

## **Vinyl ester resins**

Vinyl ester resins are most commonly used in industrial applications, especially when the composite part is exposed to aggressive media for a prolonged period of time. AOC has performed detailed studies investigating the chemical resistance of Vinyl ester resins. These are documented in AOC's Chemical Resistance Guide.

Atlac® 430 is a medium reactive vinyl ester resin known for its superior alkaline resistance. The resin is also very suitable for use in combination with carbon fiber. Atlac® 590 is a high heat resistant resin, which has good solvent resistance. Atlac® E-Nova FW 2045 is a vinyl ester urethane with very good wetting properties and superior solvent resistance.

## **Daron® high performance resins**

Daron® resins feature very good compatibility with a variety of fibers, typically independent of sizing type. Consequently, Daron® resins are used in high end applications with demanding requirements. Daron® 45/B38 is a high reactive resin system with a very high Tg. This makes it very suitable for critical applications that require high temperature resistance. Both resins show very good compatibility with multiple fibers and therefore are very suitable for use in advanced composites with carbon fibers. Daron® resins can be processed at very high speed, yielding significant increases in process output and a reduction in process cost.

## **Food contact**

For food contact applications AOC has a resin available produced produced in line with GMP (Good Manufacturing Process). Palatal® A 400-01 FC is a medium reactive isophthalic resin, very suitable for production of highly complicated profiles.



### Improved surface quality

Palapreg® P 0423-02 is a resin especially developed to create very good surface quality of composite components, when used in combination with AOC's low profile and/or low shrink additives like Palapreg® H 1080-01. It is very suitable for Automotive and Transport applications with demanding surface quality specifications.

### Fire retardant capability

Synolite™ 5011-N-1 is a resin dissolved in methacrylates. When used in combination with ATH (in high filler loads) composite components with excellent fire retardant properties can be obtained. In addition, because of the high reactivity higher pultrusion speeds are typical.

### Increased toughness

Synolite™ 4120-N-1 and Palata® E 240-02 are resins with a very high elongation at break at room temperature. These can be mixed in with other resins in order to increase total system toughness.

### DCPD resins

DCPD resins are very suitable for high filler and high glass loadings, because of their great wetting properties. AOC's most frequently used DCPD resin for pultrusion is Synolite™ 0175-N-1. Thanks to this high reactivity, pultrusion speeds are very high with conventional curing systems.

### Orthophthalic resins

Orthophthalic resins are the most commonly used resins type in pultrusion, with a good price/performance ratio. Palata® P 69-02 combines high elongation at break in combination with very good fiber wetting properties. Synolite™ 2155-N-1 is a high reactive resin that can be used for making high surface quality panels in combination with fillers and LPA additives, like Palapreg® H 1080-01.



### Isophthalic & Iso/NPG resins

Isophthalic and Iso/NPG resins are mainly used in outdoor applications because of their excellent resistance to weathering. Water absorption is low and with these resins also a very good surface quality can be obtained.

Synolite™ 0152-N-2 is a medium reactive, UV stabilized resin, developed for production of high surface quality panels used in outdoor applications. Synolite™ 1717-N-1 is a medium reactive, high temperature resistant resin with very good resistance to water, acids and hydrocarbons. Palata® A 410-01 is an Iso/NPG resin with superior water, acid and hydrocarbon resistance (medium reactive).

### Performance and versatility

AOC has a wide variety of resin solutions available to help you develop great products in a many enduse applications. Evidently the selection of the right resin depends on the application targeted and on the desired performance requirements. Please contact your AOC Sales or Technical Service representative to support you in this process.

## Physical properties of key Aliancys Pultrusion resins

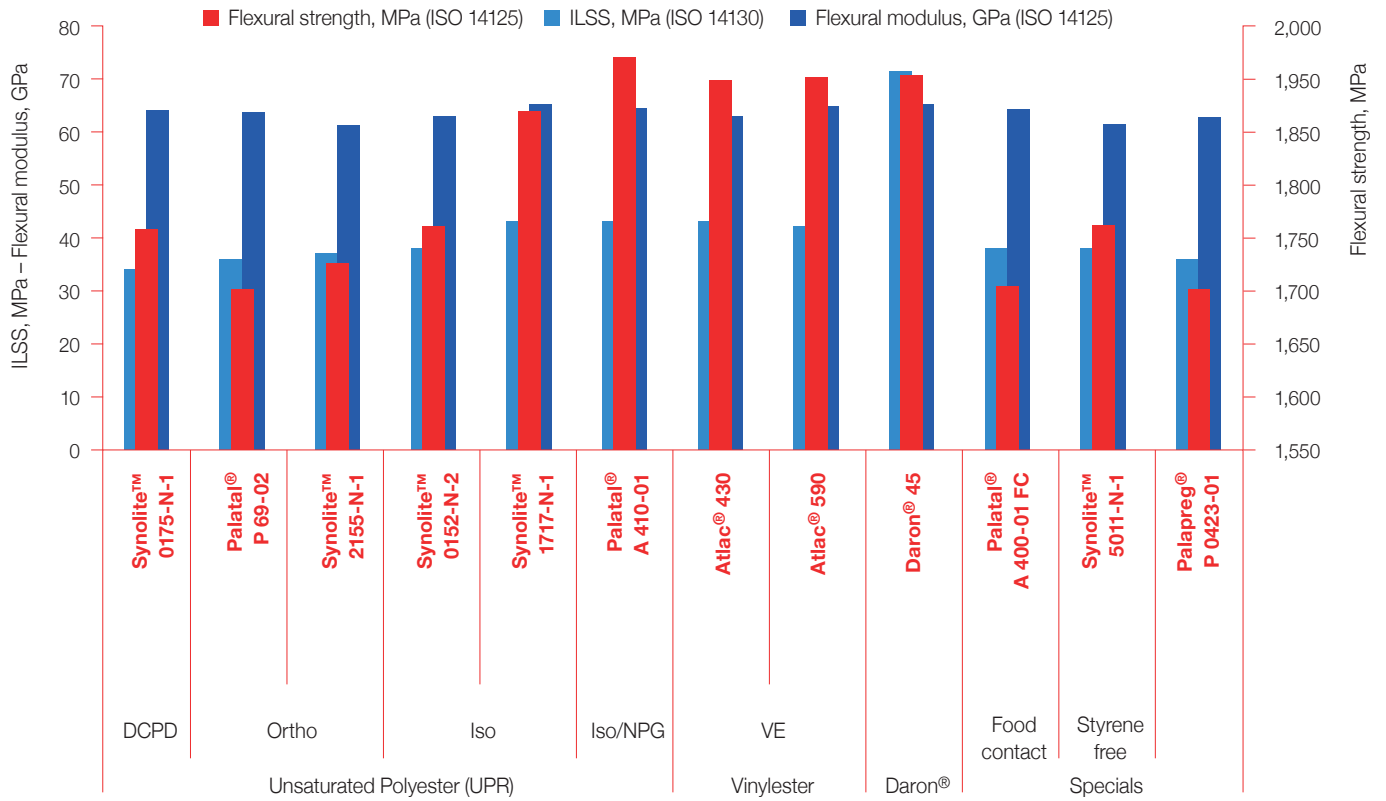
	Unit	Test method	Synolite™ 0175-N-1	Palatal® P 69-02	Synolite™ 2155-N-1	Synolite™ 0152-N-2	Synolite™ 1717-N-1	Palatal® A 410-01	Atiac® 430	Atiac® 590
<b>Solid content</b>	%	TM 2033	64-67	65-68	60-63	61-63	55-58	55-59	59-62	61.5-64.5
<b>Viscosity (100 s-1)</b>	mPa.s	TM 2013	330-430	650-750	260-290	720-950	330-420	1,100-1,300	440-500	208-282
<b>Gel time, 82° C</b>	min.	TM 2253	5.5-7.5	4.0-6.0	2-4	10-12	12-14	4.5-6.5	10-13	11-14
<b>Cure time</b>	min.	TM 2253	7.5-9.5	6.0-8.0	4-6	12-14.5	14-16	7.0-9.0	13-15	14-16
<b>Peak exotherm</b>	°C	TM 2253	210-230	220-240	230-250	200-240	220-240	210-240	200-220	220-240
<b>Tensile strength</b>	MPa	ISO 527-2	70	75	60	88	65	85	95	90
<b>Tensile modulus</b>	GPa	ISO 527-2	3.5	3.8	4.0	3.8	3.6	3.6	3.6	3.5
<b>Elongation at break</b>	%	ISO 527-2	2.5	3.4	2.0	4.2	3.5	4.4	6.1	4.0
<b>Tg<sub>(G' onset)</sub></b>	°C	ISO 6721	111	87	99	86	90	91	131	126
<b>Tg<sub>(tan d)</sub></b>	°C	ISO 6721	152	130	145	119	139	129	160	164

TM 2253: 100 g resin + 2 g Perkadox® CH50L

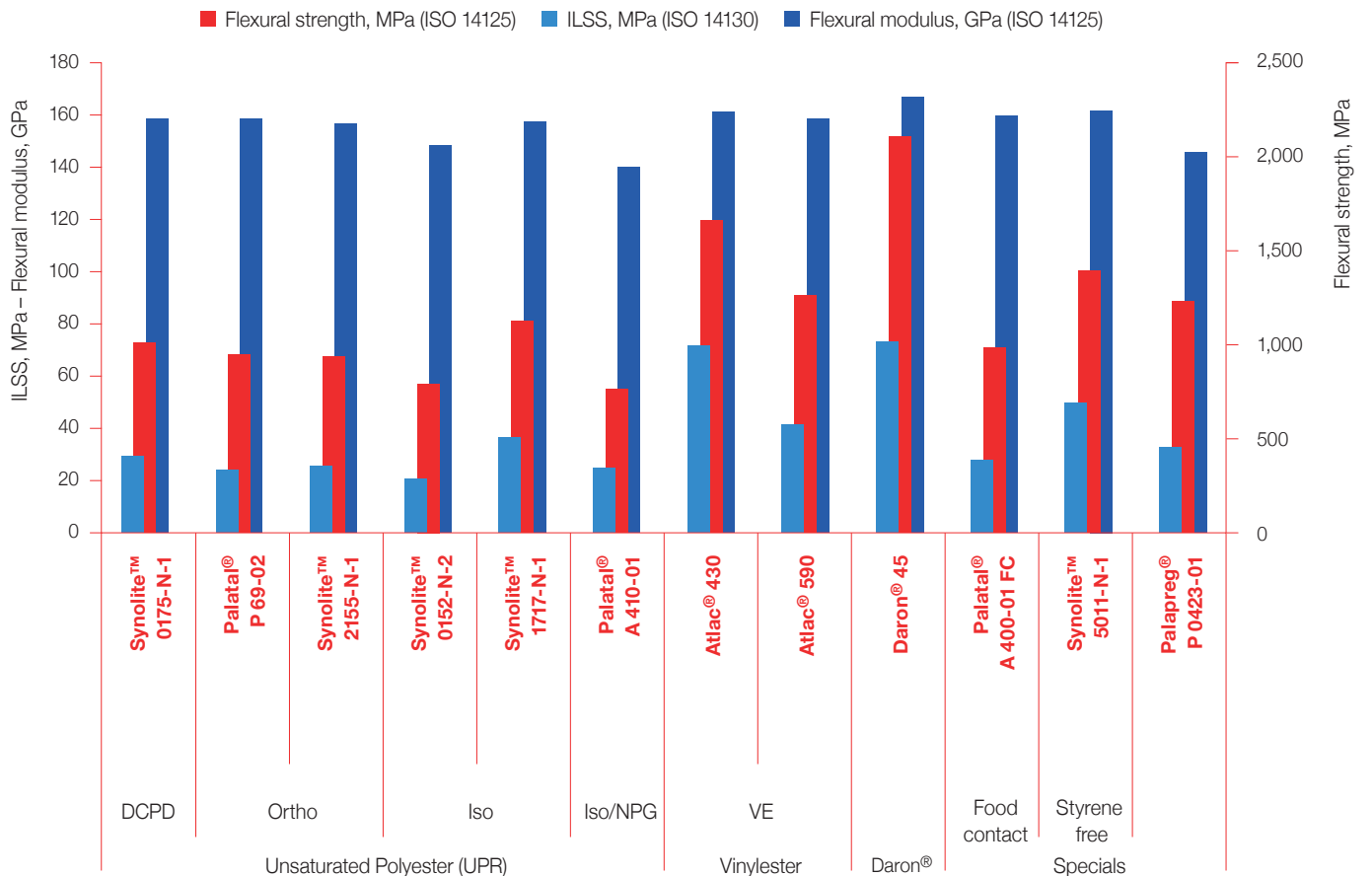
	Unit	Test method	Daron® 45/ B38	Palatal® A 400-01 FC	Palatal® E 240-02	Synolite™ 4120-N-1	Synolite™ 5011-N-1	Palapreg® P 0423-02	Palapreg® H 1080-01
<b>Solid content</b>	%	TM 2033	65-68	63-66	60-63	62-64	59-61	63.7-65.5	38-41
<b>Viscosity (100 s-1)</b>	mPa.s	TM 2013	175-225	850-1,150	300-370	500-650	30-50	1,200-1,450	3,400-4,800
<b>Gel time, 82° C</b>	min.	TM 2253	1.0-2.0	6.5-8.5	25-31	8.5-10.5	2.5-7.0	3.0-4.0	-
<b>Cure time</b>	min.	TM 2253	3.0-4.0	8.0-12.0	38-48	13-15	5.0-11.0	4.0-5.0	-
<b>Peak exotherm</b>	°C	TM 2253	215-240	200-225	85-115	155-175	170-210	250-275	-
<b>Tensile strength</b>	MPa	ISO 527-2	80	90	19	25	70	55	-
<b>Tensile modulus</b>	GPa	ISO 527-2	3.2	3.7	75	0.6	3.8	3.4	-
<b>Elongation at break</b>	%	ISO 527-2	3.0	4.5	75	90	2.2	1.7	-
<b>Tg<sub>(G' onset)</sub></b>	°C	ISO 6721	195	77	48	10	107	107	-
<b>Tg<sub>(tan d)</sub></b>	°C	ISO 6721	220	114	-	34	163	166	-

\*Can't be measured in test method

## Mechanical performance of unidirectional E-glass strip, fiber volume fraction 74%



## Mechanical performance of unidirectional carbon fiber strip (VE sized), fiber volume fraction 71%



#### **Americas**

+1 866 319 8827

[americas@aocresins.com](mailto:americas@aocresins.com)

#### **Europe, Middle East, Africa**

+41 52 644 1212

[emea@aocresins.com](mailto:emea@aocresins.com)

#### **China**

+86 25 8549 3888

[china@aocresins.com](mailto:china@aocresins.com)

#### **Asia Pacific**

+41 52 644 1212

[asiapacific@aocresins.com](mailto:asiapacific@aocresins.com)

AOC is a registered trademark of the AOC group of companies.

The information contained in this publication is based on laboratory data and field experience. We believe this information to be reliable, but do not guarantee its applicability to the user's process or assume any liability for occurrences arising out of its use. The user, by accepting the products as described herein, agrees to be responsible for thoroughly testing each such product before committing it to production.

Atlac®, Beyone®, Daron®, Firepel®, Neomould®, Neoxil®, Palatal®, Palapreg®, Synolite™, Vipel®, the AOC name, the AOC logo, and the Trusted Solutions logo are registered trademarks of the AOC group of companies.

Nothing herein is to be construed as granting permission to use, or inducing or recommending the use of any patent or resulting invention without a valid license.

The information and recommendations contained herein are to the best of our knowledge accurate and reliable, but no rights whatsoever may be derived by any party other than those expressly agreed to with a selling entity of the AOC group of companies in a legally binding agreement. AOC hereby makes no warranty of any kind, express or implied, including those of merchantability and fitness for purpose. Unless explicitly agreed to in writing by AOC otherwise, all offers, quotations, sales and deliveries of AOC products are subject to the general conditions of sale of AOC.

For more information [world@aocresins.com](mailto:world@aocresins.com)  
[aocresins.com](http://aocresins.com)

#### **Acknowledgment**

AOC would like to extend its thanks to Exel Composites, Fiberline Composites, FiReP and Vello Nordic for their support in the making of this brochure.

#### **Photography**

Angelo Giacalone, Philip Boeni, Marco Slot, Corné de Rijke.

© 2020 - AOC group of companies