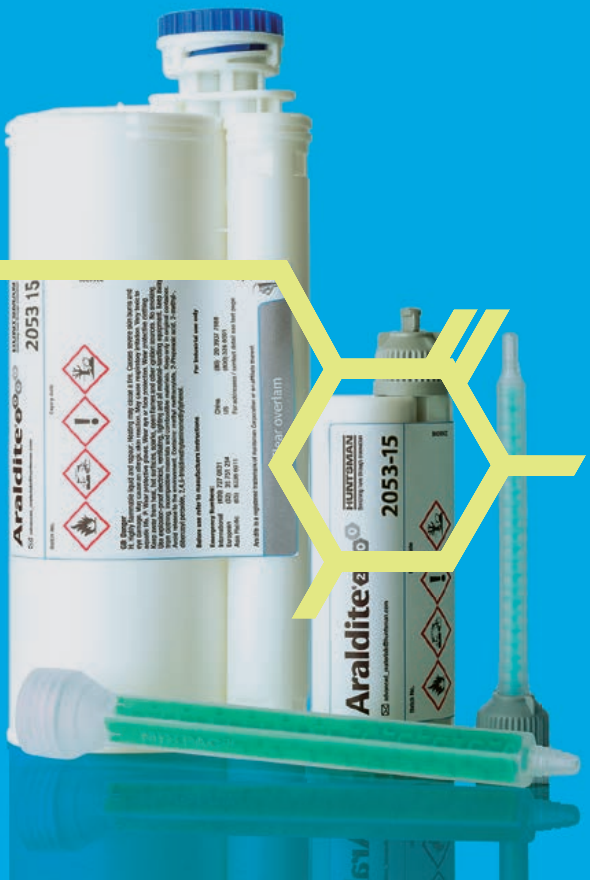
Advanced Materials

SIMPLIFY BOND SIMULATION SPEED UP DESIGN VALIDATION

Material model

ARALDITE® 2053-15

Flexible and fast curing adhesive, ideal for durable bonding under hot and wet conditions



MADE POSSIBLE

PREDICT OUTCOMES WITH UP TO 90% SUCCESS

Performance
MADE POSSIBLE

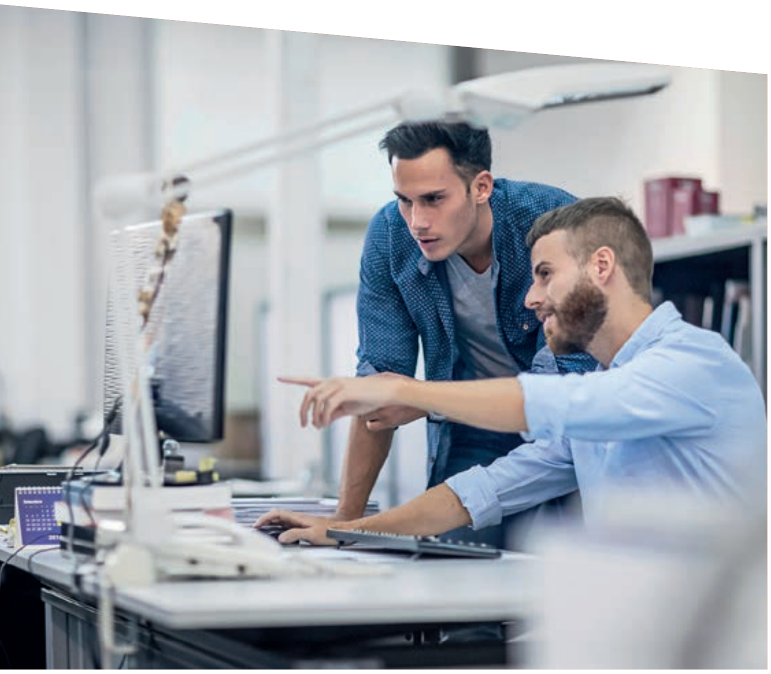
At Huntsman Advanced Materials, we make things possible.

GET READY AVAILABLE MATERIAL MODELS

With our realistic material models, you can achieve fast and accurate application simulations when qualifying adhesives for your project. Based on solid experimental characterization, our material models provide a wealth of information about the physical, mechanical and thermal behavior of our products.

GO TO MARKET FASTER

You get the data you need to predict the combined effect of design parameters and adhesives properties over the process and operational conditions of your project. Relying on our property characterization data when planning a new project helps you reduce time and budget spent for your qualification process.



> While numerical simulation is widely recognized as a robust tool to assist design of adhesively bonded structures, its applicability relies on realistic material models based on solid experimental characterization.

CHARACTERIZATION DATA OVERVIEW

ARALDITE® 2053-15
ADHESIVE

International units | US customary units

Tensile resistance at ISO 527	**Tensile strength**	**Tensile modulus**	**Elongation at break**
-40°C	64 MPa	3,200 MPa	2%
-20°C	44 MPa	2,200 MPa	5%
0°C	33 MPa	1,900 MPa	18%
23°C	23 MPa	1,300 MPa	66%
40°C	16 MPa	730 MPa	150%
60°C	11 MPa	200 MPa	220%
80°C	8 MPa	29 MPa	260%
100°C	5 MPa	12 MPa	260%

Poisson's ratio at 23°C ISO 527	0.42	
Shear modulus at 23°C (G) Calculation	460 MPa	
Fracture toughness at 23°C ISO 13586 based internal method	**K_{1c}**	**G_{1c}**
	3.2 MN/m$^{3/2}$	12,000 J/m^2
Coefficient of thermal expansion ISO 11359	**-40°C / 60°C**	**60°C / 200°C**
	122 ppm/K	not measurable
Tg ISO 6721	**Onset**	**Peak**
	37°C	107°C
Storage modulus G' at 23°C ISO 6721	840 MPa	
Lap shear strength at 23°C ISO 4587 - on sandblasted aluminium 5754	16.2 MPa	
T-peel strength at 23°C ISO 11339 - on sandblasted aluminium L165	3.2 N.mm^{-1}	
Cured density at 23°C ISO 1183	1.26	
Volumetric shrinkage at 23°C Calculation	19%	
Shore hardness D at 23°C ISO 868	71	

CHARACTERIZATION DATA OVERVIEW

ARALDITE® 2053-15
ADHESIVE

International units | **US customary units**

Tensile resistance at ISO 527	**Tensile strength**	**Tensile modulus**	**Elongation at break**
-40°F	9,282 psi	464 ksi	2%
-4°F	6,382 psi	319 ksi	5%
32°F	4,786 psi	276 ksi	18%
73°F	3,336 psi	189 ksi	66%
104°F	2,321 psi	106 ksi	150%
140°F	1,595 psi	29 ksi	220%
176°F	1,160 psi	4.2 ksi	260%
212°F	725 psi	1.7 ksi	260%

Poisson's ratio at 73°F ISO 527	0.42	
Shear modulus at 73°F (G) Calculation	67 ksi	
Fracture toughness at 73°F ISO 13586 based internal method	**K_{1c}**	**G_{1c}**
	3.2 $MN/m^{3/2}$	12,000 J/m^2
Coefficient of thermal expansion ISO 11359	**-40°F / 140°F**	**140°F / 392°F**
	122 ppm/K	not measurable
Tg ISO 6721	**Onset**	**Peak**
	99°F	225°F
Storage modulus G' at 73°F ISO 6721	122 ksi	
Lap shear strength at 73°F ISO 4587 - on sandblasted aluminium 5754	2,320 psi	
T-peel strength at 73°F ISO 11339 - on sandblasted aluminium L165	18.3 pli	
Cured density at 73°F ISO 1183	1.26	
Volumetric shrinkage at 73°F Calculation	19%	
Shore hardness D at 73°F ISO 868	71	

CHARACTERIZATION DATA

ARALDITE® 2053-15 ADHESIVE

TENSILE RESISTANCE →

POISSON’S RATIO →

FRACTURE TOUGHNESS →

COEFFICIENT OF THERMAL EXPANSION →

GLASS TRANSITION TEMPERATURE →

LAP SHEAR STRENGTH →

T-PEEL STRENGTH →

CURED DENSITY →

VOLUMETRIC SHRINKAGE →

SHORE HARDNESS →

ASSESS ABILITY TO WITHSTAND ELONGATION

▶ More about the testing method

▶ See characterization data

Behavioral properties of adhesives exposed to variable stresses and their ability to withstand strain without breaking, are vital when determining the most suitable adhesive for an application.

Tensile tests are designed to assess the risk of fractures caused by stress and load in addition to the amount of strain (elongation) that is reached at predetermined values.

The results obtained for tensile resistance provides information on breaking points and the specific level of tolerance in relation to a longitudinal stress.

TENSILE RESISTANCE

MEASURE DIMENSIONAL CHANGE UNDER LOAD

▶ More about the testing method

▶ See characterization data

When an adhesive specimen is stretched in a longitudinal direction, it tends to get thinner laterally. The measurement of the relationship between how far a material is stretched and how thin it gets during stretching is an invaluable metric that helps product development teams to determine a threshold of tolerance.

The Poisson’s ratio is primarily used by engineers to identify exactly how much material can be stretched or compressed before it fails. This is commonly used in the designing of new structures because it allows engineers to consider the expected dimensional changes of a given material when under load.

The Poisson’s ratio measures the degree of change in length and width of the material as it stretched in longitudinal and lateral directions.

POISSON’S RATIO

ASSESS RESISTANCE TO FATIQUE PRE-CRACK

- More about the testing method
- See characterization data

Adhesives in application are commonly exposed to various degrees of indirect and direct strain. We understand the need to have confidence in the ability of our adhesives to tolerate such strain.

The fracture toughness test is fit for purpose. It calculates and characterizes the toughness of material and is measured as a critical-stress-intensity factor, expressed as (K_{1C}). Additionally, the test measures the energy per unit area of crack surface or critical strain energy release rate, expressed as (G_{1C}) at the time of fracture initiation.

These measurements determine the overall resistance of a material against a load that is applied resulting in crack extension and also crack growth of a specimen that contains a fatigue pre-crack.

FRACTURE TOUGHNESS

PREVENT FAILURE BY THERMAL STRESS

▶ More about the testing method

▶ See characterization data

Under the effects of increasing temperature any material expands, leading to changes in dimensions, to part warpage or to internal stress, which can result in premature failure to occur.

Thermal expansion testing, also referred as the Coefficient of Linear Thermal Expansion (CLTE) is a universal test method designed to measure the specific rate at which a material expands at a precise temperature or over a temperature range. CLTE is commonly used for design purposes and can determine if failure by thermal stress is likely to occur.

This is of particular interest to application areas such as the automotive and aerospace sectors where the thermal environment experiences constant change. Understanding the relative expansion/contraction characteristics of two materials in contact is therefore critical to determine application success.

COEFFICIENT OF THERMAL EXPANSION

CONSIDER CHANGE OF STATE FROM HARD TO FLEXIBLE

- ▶ More about the testing method
- ▶ See characterization data

Glass transition temperature (Tg) is a measurement of the temperature range that indicates where the adhesive changes from a hard glassy material to a soft flexible material. It is often measured in terms of the stiffness, or modulus and is also referred to as the main relaxation.

Glass transition temperatures are extremely variable. This is related to many factors including curing process and moisture content.

This test ensures the right application is established and the overall adhesive performance can be achieved given that some adhesives will operate below their glass transition temperature. i.e. in their glassy state, while others will perform above their Tg, where they are soft and supple.

GLASS TRANSITION TEMPERATURE

EVALUATE LONG-TERM PERFORMANCE AND DURABILITY

▶ More about the testing method

▶ See characterization data

Understanding the amount of shear force that can be exerted on a lap joint before failure occurs is an important measurement for product qualification. Shear force remains one of the most common stresses that a bonded joint can face during service, especially in structural bonding applications.

Long-term performance is a critical characteristic of any adhesive and measuring shear strength is a favored method for many industries. Adhesive strength, surface preparation criteria and the adhesive environmental durability make up the assessment in addition to:

- **Serviceability and efficiency of adhesives**
- **Influence of bonding conditions such as cleaning methods, humidity and curing temperature**
- **Influence of external factors such as storage in the presence of chemicals and at elevated temperatures**

LAP SHEAR STRENGTH

MEASURE ACTUAL BONDING STRENGTH

▶ More about the testing method

▶ See characterization data

Understanding how much force is required to progressively separate two bonded, flexible adherends, provides product engineers with vital information to understand the actual strength of an adhesive.

Quantifying the peel resistance of an adhesive, provides data and insights for product optimization in processes in addition to meeting the qualification standards of a customer specification.

The T-peel strength test determines precisely the degree of stress that can be applied in a peeling mode to initiate and or maintain a specified rate of failure.

T-PEEL RESISTANCE

PREDICT VARIATIONS IN PHYSICAL STRUCTURE

▶ More about the testing method

▶ See characterization data

The measurement of density measures unit volume of a material. Density in this instance can be regarded as a way to represent the degree of compactness of an adhesive measured in mass per unit of volume. Measuring density has proven to be extremely useful in assessing the uniformity of samples and specimens and is frequently used to follow variations in physical structure or the composition of adhesives.

Characterizing density of an adhesive and interpreting the implications provides vital information improving bond performance. It also helps in the general understanding of the polymer more completely in regards to improved application.

Product engineers consider this a highly valuable investigation as it enables greater application of adhesives in non-uniformed situations, helping to maintain appropriate adhesive coverage.

CURED DENSITY

PREVENT IMPACT OF VOLUME CONTRACTION

▶ More about the testing method

▶ See characterization data

Optimization of the curing process is paramount for the strength of high quality adhesives. Knowing the entire composition of the adhesive enables to provide details on the likely degree of contraction and shrinkage, also known as warpage of an adhesive. Processing conditions like temperature, pressure and flow rate, coupled with overall part design geometry will impact the potential for volume contraction of the polymers.

Commonly, this contraction is due to the difference of density of polymers from the melt state and the cooled / rigid state.

Volumetric shrinkage testing is an important diagnostic that enables to understand and prevent part deformity and any associated changes in part stiffness and shape that can lead to cracks and long term failure of a finished product.

VOLUMETRIC SHRINKAGE

ASSESS ABILITY TO WITHSTAND DEFORMATION

▶ More about the testing method

▶ See characterization data

When you require a higher threshold of impact, conducting a shore hardness test accurately calculates the hardness of materials like adhesives. Establishing the level of direct impact and penetration an adhesive is able to withstand, provides a common reference point when comparing different candidates.

Higher numbers on the scale indicate a greater resistance to indentation and thus harder materials while lower numbers indicate less resistance and softer materials.

Shore hardness tests are of high importance as the values are known to differ when comparing adhesives.

SHORE HARDNESS

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