Vantico Ltd.

Electronic Polymers

vantico

Heavy Electrical

®Araldite Casting Resin System

Araldite	**B_{41} or B_{46}**	**100**	**pbw**
Hardener	**HT 901 or HT 903-1**	**30 or 40**	**pbw**
Mineral fillers		**200-250**	**pbw**

Solid, hot-curing casting resin system for producing castings with good electrical and mechanical end-properties.

Applications

Indoor electrical insulators for medium and high voltage applications, such as instrument transformers, switchgear components and for structural parts for equipment subject to high mechanical, thermal or chemical stress.

Processing methods

Conventional gravity casting process under vacuum

The choice of the resin and hardener is determined by the application envisaged and the processing equipment available.
Pot life and exothermic temperature rise can be controlled by appropriate selection of the resin, hardener and filler combination used.

Properties

Void-free epoxy resin castings exhibit outstanding resistance to mechanical, thermal and electrical stress even under long-term loading.
Low cure shrinkage allows the manufacture of large-volume castings and the crack-free encapsulation of metal parts and conductors.

Edition: **July 2000**
Replaces Edition: March 2000

Araldite B_{41}

Araldite B_{46}

Unmodified, Bisphenol A based epoxy resins with viscosities and reactivities closely tailored to complement the properties of the recommended hardeners.

They contain no solvent and are odourless solids at room temperature

				Araldite B41	Araldite B46
Viscosity	at 120°C	DIN 53019	mPa s	390-520	650-850
Viscosity increase,	120°C/24h		%	≤ 12	≤ 12
Melting range			°C	35-50	35-50
Epoxy content		ISO 3001	equiv./kg	2.55-2.70	2.30-2.45
Flash point		DIN 51758	°C	>200	>200
Density	at 25°C	ISO 1675	g/cm³	1.15-1.25	1.15-1.25
Volatile content			%	0.0 - 0.2	0.0 - 0.2
Vapour pressure	at 150°C	(Knudsen)	Pa	1	1
Aspect		solid, pale yellow or yellow resin			

Hardener HT 901

Hardener HT 903-1

Carboxylic acid anhydride based curing agents which are odourless solids at room temperature.

The hardeners HT 901 and HT 903-1 are sensitive to moisture, absorption of which leads to the formation of acid that detrimentally affects the reactivity of the mix and the end properties of castings

				Hardener HT 901	Hardener HT 903-1
Melting range			°C	128-132	79 - 83
Flash point		DIN 51758	°C	140	135
Density	at 25°C	ISO 1675	g/cm³	1.48-1.53	1.48-1.53
	at 130°C	ISO 1675	g/cm³	1.22-1.25	1.22-1.25
Vapour pressure	at 130°C	(Knudsen)	Pa	800	500
Acid content			%	≤3	≤3
Volatile content			%	0.0 - 0.2	0.0 - 0.2
Aspect		white powder	Apr.		

Accelerator DY 068

Low-viscosity, carboxylic acid anhydride based catalyst containing cure-accelerating agents.

Addition of this accelerator to a resin-hardener combination results in a highly reactive mix primarily suitable for processing by the pressure gelation method.

Viscosity	at 25°C	DIN 53019	mPa s	<300
Density	at 25°C	ISO 1675	g/cm³	1.15-1.20
Flash point		DIN 51758	°C	172
Vapour pressure	at 110°C	(Knudsen)	Pa	100

Storage

The components have to be stored under dry conditions at 18-25°C, in tightly sealed original containers. Product specific advise regarding storage can be found on product label. Under these conditions, the shelf life will correspond to the expiry date stated on the label. After this date, the product may be processed only following reanalysis. Partly emptied containers should be closed tightly immediately after use.
For information on waste disposal and hazardous products of decomposition in the event of fire, refer to the Material Safety Data Sheets (MSDS) for these particular products.

Fillers

The addition of powdered mineral fillers such as silica flour, microdol and aluminium oxide is recommended when manufacturing castings that will be required to withstand mechanical, electrical or thermal stress.
The incorporation of mineral fillers

- modifies major mechanical and electrical properties;
- reduces shrinkage and exothermic temperature rise during cure;
- imparts a low coefficient of linear expansion;
- improves thermal conductivity;
- reduces unit costs.

The reduction of elongation at break resulting from the use of filler may be a drawback under certain conditions.

The glow heat resistance and flame-retarding properties of castings can be enhanced by substituting some part of the silica flour filler with Aluminium Oxide Trihydrate. A slight impairment of mechanical and dielectric properties is acceptable.

Depending on processing conditions and the application for which castings are intended, filler loadings of up to 250 pbw may be used.

The data given below for filled systems were determined by test specimens containing 200 pbw W12 grade silica flour supplied by Quarzwerke GmbH, Frechen, Germany.

The end properties of a casting are dependent to a marked degree on the type, grade, amount and origin of the filler incorporated, on the pretreatment it was given, and on the way it was added to the mix. For instance, silanized silica flour filler has been found to impart appreciably more durable dielectric properties to a casting exposed to tropical weathering. Filler should be predried if it is to be used in high Electronic castings.

The impurity content of the filler affects the processing properties of the casting resin mix. It is advisable to test the reactivity and exothermic characteristics with every new batch of filler before continuing production.

The particle size distribution of a filler influences the flow properties of a casting mix, the gel time and the end properties of castings. Test results deviating from those quoted in this Instruction Sheet are to be expected if casting mixes are formulated using fillers other than those shown.

Coarse fillers have an undesirable tendency to settle out, ultimately promoting built-in stresses in castings.

CAUTION

Anti-dust safety precautions should always be taken, particularly when filler handling generates fine quartz-containing dust that could cause silicosis.

System Preparation

General instructions for preparing solid resin systems
Long pot life is desirable in the processing of any casting resin system. The resin component melted to 120-150°C, together with the dried filler and eventually further additives, will be first premixed under vacuum in the premixer. Intensive wetting of the filler is extremely important. Proper mixing will result in:
- better flow properties and reduced tendency to shrinkage
- lower internal stresses and therefore improved mechanical properties on object
- improved partial discharge behaviour in high voltage applications.

The quantity of premix needed for a casting operation will be transferred to the final mixer and the appropriate quantity of the hardener (at room temperature) will be added. After reaching appr. 5 mbar of vacuum, the vacuum pump has to be turned off. Following, the mixer is turned on. After intensive mixing of appr. 10 - 20 min the casting resin system is ready. The temperature will decrease to appr. 100-120°C and the vacuum did regulate itself to appr. 8 mbar. Now it can be cast directly into the preheated moulds in the autoclave at 120-140°C and under a vacuum of appr. 10-15 mbar.

The mixing time of the premix (resin/filler) can vary from 1 to 3 hours, depending on mixing temperature, quantity, mixing equipment and the particular application. The required vacuum is 0.5 to 3 mbar. The vapour pressure of the individual components should be taken into account.
In the case of electrically highly stressed parts, we recommend checking the quality consistency and predrying of the filler. The moisture content should be $\leq$0.2%.

Specific Instructions

The effective pot-life of the mix is about 1 - 2 hours at temperatures below 120°C. Conventional batch mixers should be cleaned once a week or at the end of work.

Viscosity increase and gel time at various temperatures, refer to Figs: 6.1 and 6.4.

Mould temperature

Conventional vacuum casting	120 - 140°C

Demoulding times (depending on mould temperature and casting volume)

Conventional vacuum casting	4 - 8 h

Cure conditions (minimal postcure)

Conventional Vacuum Casting	10 - 20h at 140°C

For castings with big volume (exothermic reaction, internal mechanical stresses) or encapsulation of heat sensitive active parts could be cured at appr. 80°C.
To determine whether crosslinking has been carried to completion and the final properties are optimal, it is necessary to carry out relevant measurements on the actual object or to measure the glass transition temperature (Tg). Different gelling and cure cycles in the manufacturing process could lead to a different crosslinking and glass transition temperature respectively.

Processing

(guideline values)

Mix ratios **Conventional Casting**

System	**1**	**2**	**3**	**4**	**5**	**6**
Araldite B_{41}	100	100	-	100	100	-
Araldite B_{46}	-	-	100	-	-	100
HT 901	30	30	30	-	-	-
HT 903-1	-	-	-	40	40	40
Silica Flour W12	-	200	200	-	200*	200*

* A filler loading of up to 250 part pbw (64%) would be feasible

Pretreatment of resin, addition of filler

Araldite B41 or B46 is heated to obtain a clear, liquid melt to which the, usually, preheated and degassed filler and the required amount of colouring paste are added. This mix is degassed under constant stirring prior to adding the hardener.
The following guidelines apply :

	unfilled	filled
Resin melt temperature	ca. 130°C	ca. 150°C
Filler preheating temperature	-	130 - 150°C
Degassing at	0.5 - 3 mbar	0.5 - 3 mbar
Mix time under vacuum	½ - 1h	1 - 3h

Addition of cold hardener

Hardener HT 901 or HT 903 is added when the mixer is stopped. The mixing chamber is then again put under a vacuum, the vacuum line closed off, and the mixer put in motion. To ensure rapid and complete melting of the hardener the following requirements should be met.

	HT 901	HT 903-1
Required end temperature of total mix	130-135°C	100 - 120°C
Temperature of resin/filler mix	140-150°C	120 - 140°C
Vacuum at 100°C	-	ca. 1 mbar
Vacuum at 110° C	-	ca. 2 mbar
Vacuum at 120° C	-	ca. 5 mbar
Vacuum at 130°C	ca. 8 mbar	-
Mix time under vacuum 1	0-20 min	10 - 20 min

Addition of liquefied hardener

Hardener HT 901 and Hardener HT 903-1 can be liquefied at 130-135°C and 90-110°C respectively prior to being added to the resin-filler mix, the temperature of which should be reduced accordingly. Use of liquefied hardener makes it easier to control the temperature of the casting mix.

Processing Viscosities

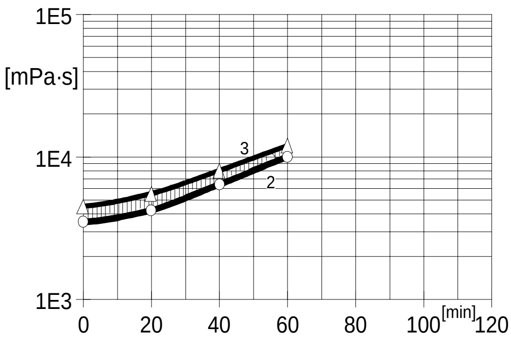

Fig.6.1: **Viscosity versus time and temperature**
Systems 2 and 3 at 120°C

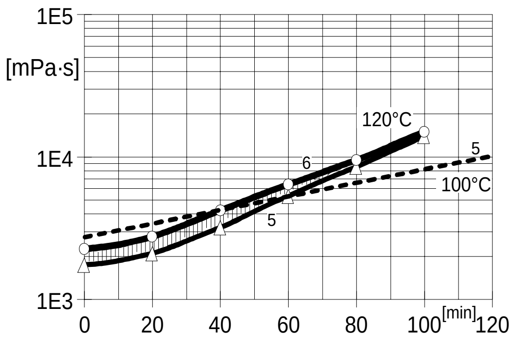

Fig. 6.2: **Viscosity versus time and temperature**
Systems 5 and 6 at 120°C, System 5 at 100°C

Gelation- / Cure Times

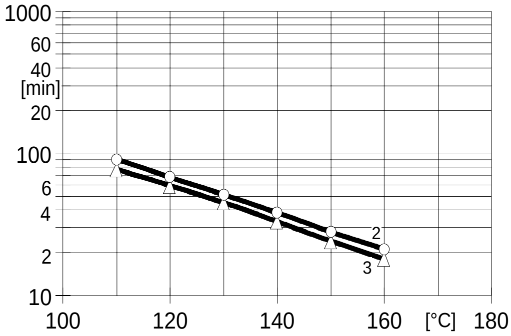

Fig.63: **Geltime in function of temperature**
(DIN 16945/6.3.1)
Systems 2 and 3

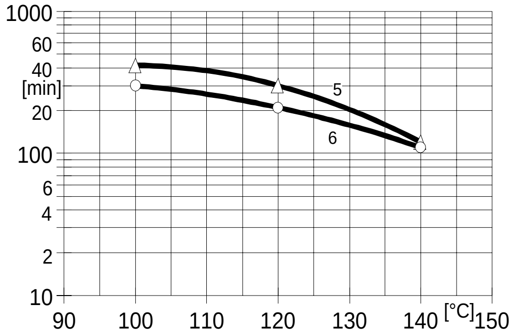

Fig.6.4: **Geltime in function of temperature**
(DIN 16945/6.3.1)
Systems 5 and 6

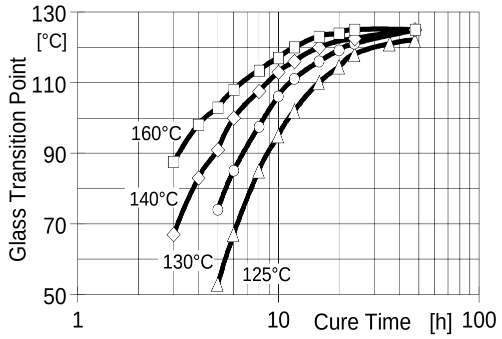

Fig.6.5: **Glass transition temperature in function of the cure time**
(isothermic reaction, IEC 1006)
Araldite B41/B46:HT 901:Silica (100:30:200 pbw)

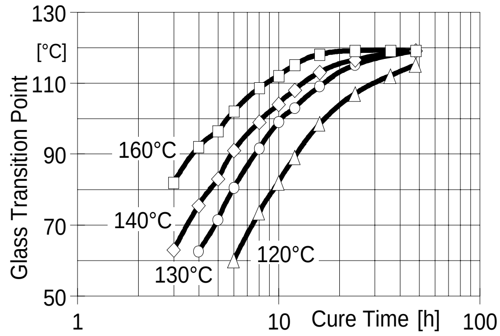

Fig.5.5: **Glass transition temperature in function of the cure time**
(isothermic reaction, IEC 1006)
Araldite B41/B46:HT 903-1:Silica (100:40:200 pbw)

(guideline values)

Determined on standard test specimen at 23°C Cured for 16h at 140°C			System 1*	System 2	System 3	System 4*	System 5	System 6
Tensile strength (max.)	ISO R 527	MPa	70-90	80-100	80-100	60-85	70-90	70-90
Elongation at break	ISO R 527	%	5-7	1.0-1.4	1.0-1.4	5-6	1.0-1.3	1.0-1.3
E modulus from tensile test	ISO R 527	MPa	3700-4500	9600-10600	9600-10600	3700-4500	9600-10600	9600-10600
Flexural strength (max.)	ISO 178	MPa	100-120	130-150	130-150	100-120	120-140	120-140
	DIN 53452	MPa	140-150	140-150	145-155	140-150	130-140	135-140
Surface strain	DIN 53452	%	8	1.7	1.8	9	1.9	2.0
Compressive strength (max)	ISO 604	MPa	100-130	180-200	180-200	100-130	180-200	180-200
Ball indentation hardness								
30-sec value, Method b	ISO DR 2039	MPa	90-100	130-150	130-150	90-100	130-150	130-150
Deflection	ISO 178	mm	17-19	3.5-4.0	3.5-4.0	17-19	3.5-4.0	3.5-4.0
	DIN 53452	mm	12-14	2.5-3.5	2.5-3.5	13-15	3-4	3-4
Impact strength	ISO 179	kJ/m²	40-50	14-19	14-19	40-60	16-22	16-22
Notched impact strength	ISO 179	kJ/m²	5-7	2-3	2-3	5-7	2-3	2-3
Double Torsion Test	CG 216-0/89							
Critical stress intensity factor (K_{IC})		MPa·m½	-	-	-	-	2.3-2.5	2.3-2.5
Specific energy at break (G_{IC})		J/m²	-	-	-	-	500-550	500-550
Photoelastic constant S	(kg/cm²)/magnitude.cm		10.3	-	-	10.3	-	-
Martens temperature	DIN 53458	°C	90-100	105-115	105-115	80-90	90-105	90-105
Glass transition temperature (DSC)	IEC 1006	°C	115-130	115-130	115-130	105-120	105-120	105-120
Coefficient of linear thermal expansion	DIN 53752							
Mean value for temperature range: 20 - 60°C		$K^{-1} \cdot 10^{-6}$	60-65	34-37	34-37	60-65	34-37	34-37
Thermal conductivity at 80°C	DIN53612	W/mK	0.17-1.23	0.8-0.9	0.8-0.9	0.15-0.20	0.7-0.8	0.7-0.8
Specific heat		kJ/kg·K	0.28	0.20	0.20	0.28	0.20	0.20
Glow heat resistance	DIN 53459	class-	3a	2b	2b	3a	2b	2b
Decomposition temperature	VSM 77113	°C	350-360	350-360	350-360	350-360	350-360	350-360
Water absorption (specimen: 50x50x4 mm)								
10 days at 23°C	ISO 62	% by wt.	0.25-0.35	0.15-0.25	0.15-0.25	0.25-0.35	0.15-0.25	0.15-0.25
30 min at 100°C	ISO 117	% by wt.	0.20-0.25	0.10-0.20	0.10-0.20	0.20-0.30	0.10-0.20	0.10-0.20
Decomposition temperature (heating rate: 10K/min)								
Density	DIN 55990	g/cm³	1.15-1.25	1.6-1.7	1.6-1.7	1.15-1.25	1.6-1.7	1.6-1.7

* These figures apply with minor variations for all unfilled Araldite B castings.

Electrical Properties

(guideline values)

Determined on standard test specimen at 23°C
Cured for 16h at 140°C

			System 1	Systems 2-3	System 4	Systems 5-6
Electric strength measured using 2mm thick specimens. Electrodes: cylindrical, diameters 25 and 75 mm, in castor oil						
20-sec value, 23°C/50Hz	IEC 243	kV/mm	21-23	23-25	21-23	23-25
90°C/50Hz		kV/mm	18	23	18	23
Surge breakdown voltage (1/50µs), 3 surges per step						
mean value		kV	111	111	-	-
mean thickness		mm	3.54	3.16	-	-
mean field strength		kV/mm	31.4	35.2	-	-
HV arc resistance	DIN 53484	grade	L1	L4	L1	L4
	ASTM D 495	s	-	186-192	-	186-192
Tracking resistance	IEC 112	V	>600	400	>600	400
	DIN 53480	grade	KA 3a	KA 1	KA 3a	KA 1
Electrolytic corrosion	DIN 53489	grade	A1	A-AB 1-1.2	A1	AN 1.2

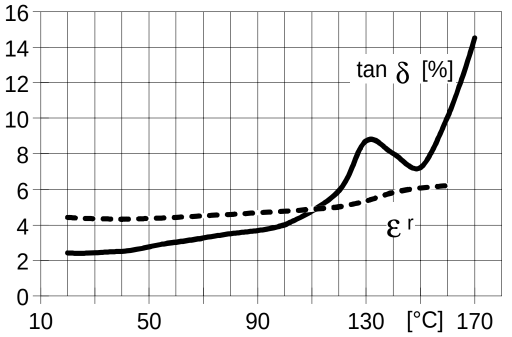

Fig.8.1: **Loss factor (tan δ) and dielectric constant (εr) in function of temperature**
(measurement frequency: 50 Hz, IEC 250/ DIN 53483)
Systems 2 and 3

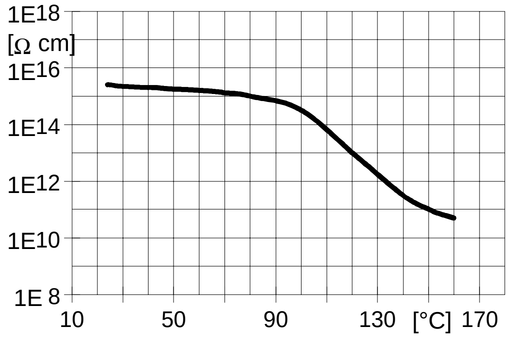

Fig.8.2: **Volume resistivity (ρ) in function of temperature**
(measurement voltage: 1000 V, IEC 93/ DIN 53482) **Systems 2 and 3**

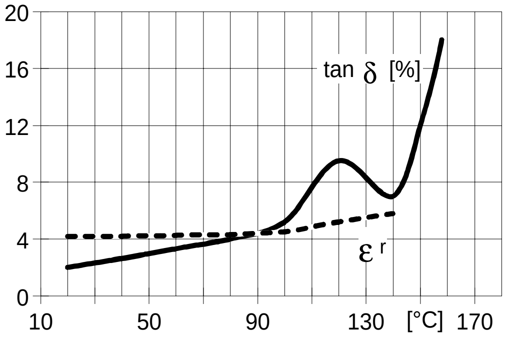

Fig.8.3: **Loss factor (tan δ) and dielectric constant (εr) in function of temperature**
(measurement frequency: 50 Hz, IEC 250/ DIN 53483)
Systems 5 and 6

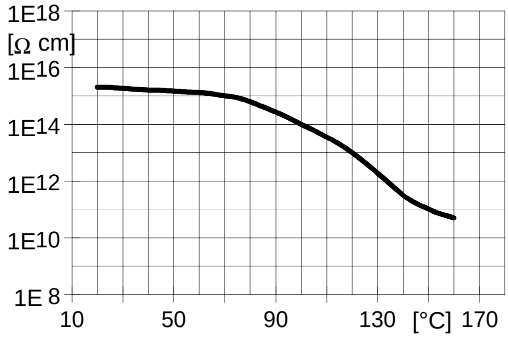

Fig.8.4: **Volume resistivity (ρ) in function of temperature**
(measurement voltage: 1000 V, IEC 93/ DIN 3482) **Systems 5 and 6**

Heat ageing according to DIN 53446

Determined on standard test specimen
Cured for 8h at 160°C

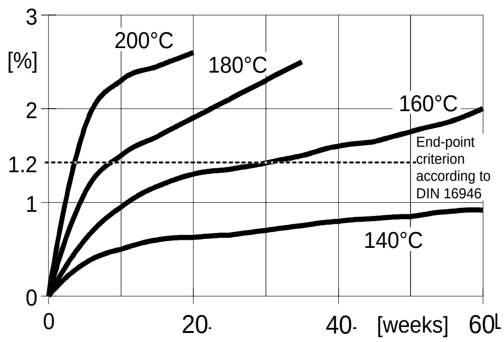

Fig.9.1: **Weight loss** (DIN 16946)
(limit: 1.2%)
System 2

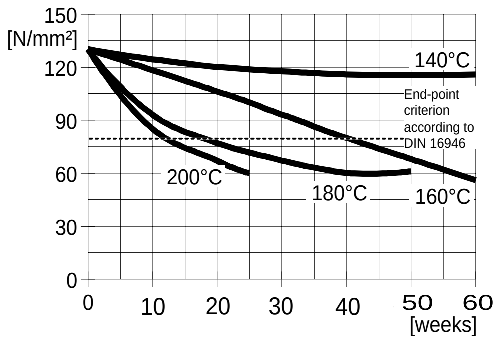

Fig.9.2: **Loss of flexural strength** (DIN 16946)
(limit: 50%)
System 2

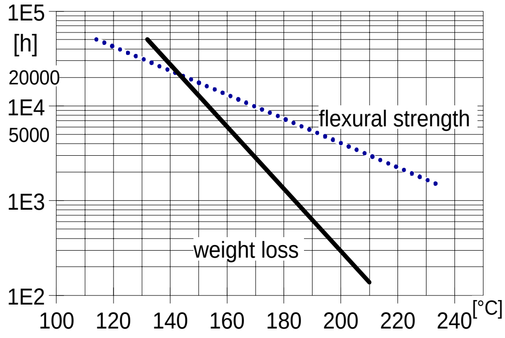

Fig.9.3: **Temperature-time curves**
(derivated from times for end-point criterion)
System 2

Water absorption

Determined on standard test specimen (60x10x4mm)
Cured for 16h at 140°C

Araldite B_{41}/B_{46}: 100 pbw
Hardener HT 901: 30 pbw

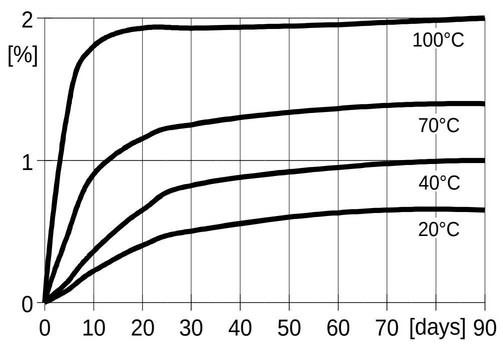

Fig.9.4: **Absorption of water as a function of immersion time at 20°c, 40°C, 70°C and 100°C**

Special Properties and Values

(guideline values)

Tensile creep characteristics

Determined on standard test specimen
Cured for 16h at 140°C

Araldite B_{41}/B_{46}: 100 pbw
Hardener HT 901: 30 pbw
Silica flour W12: 200 pbw
(System 2 + 3)

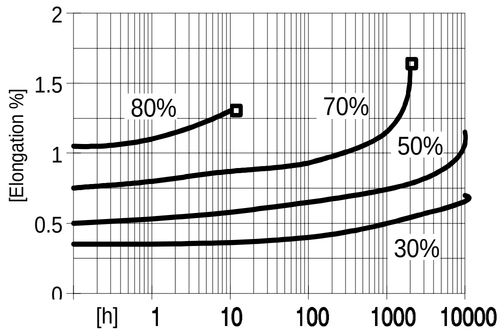

Fig.10.1: **Test temperature 23°C**
Tensile strength σ_z (23°C) 87N/mm2
(❐ = failure)
System 2

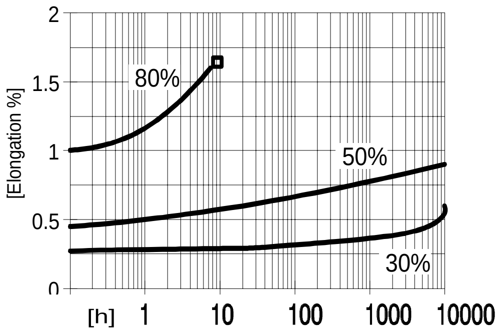

Fig.10.2: **Test temperature 40°C**
Tensile strength σ_z (40°C) 85N/mm2
(❐ = failure)
System 2

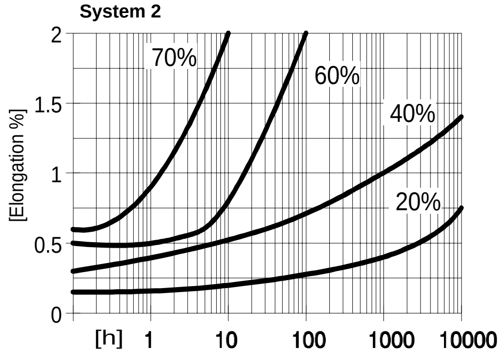

Fig.10.3: **Test temperature 85°C**
Tensile strength σ_z (85°C) 57N/mm2
System 2

Determined in accordance with DIN 53444

The tensile specimens were loaded to give stresses equal to the indicated percentages of the initial short-term failure stresses of the material at the temperatures shown

Industrial hygiene

Mandatory and recommended industrial hygiene procedures should be followed whenever our products are being handled and processed. For additional information please consult the corresponding Safety Data Sheets and the brochure "Hygienic precautions for handling plastics products of Ciba Specialty Chemicals Inc. (Publ. No. 24264/e).

Handling precautions

Safety precautions at workplace:	
protective clothing	yes
gloves	essential
arm protectors	recommended when skin contact likely
goggels/safety glasses	yes
respirator/dust mask	recommended
Skin protection	
before starting work	Apply barrier cream to exposed skin
after washing	Apply barrier or nourishing cream
Cleaning of contaminated skin	Dab off with absorbent paper, wash with warm water and alkali-free soap, then dry with disposable towels. Do not use solvents
Clean shop requirements	Cover workbenches, etc. with light coloured paper Use disposable breakers, etc.
Disposal of spillage	Soak up with sawdust or cotton waste and deposit in plastic-lined bin
Ventilation:	
of workshop	Renew air 3 to 5 times an hour
of workplace	Exhaust fans. Operatives should avoid inhaling vapours.

First Aid

Contamination of the **eyes** by resin, hardener or casting mix should be treated immediately by flushing with clean, running water for 10 to 15 minutes. A doctor should then be consulted.
Material smeared or splashed on the **skin** should be dabbed off, and the contaminated area then washed and treated with a cleansing cream (see above). A doctor should be consulted in the event of severe irritation or burns. Contaminated clothing should be changed immediately.
Anyone taken ill after **inhaling** vapours should be moved out of doors immediately.
In all cases of doubt call for medical assistance.

Vantico Ltd.
Electronic Polymers

All recommendations for use of our products, whether given by us in writing, verbally, or to be implied from results of tests carried out by us are based on the current state of our knowledge. Notwithstanding any such recommendations the Buyer shall remain responsible for satisfying himself that the products as supplied by us are suitable for his intended process or purpose. Since we cannot control the application, use or processing of the products, we cannot accept responsibility therefore. The Buyer shall ensure that the intended use of the products will not infringe any third party's intellectual property rights. We warrant that our products are free from defects in accordance with and subject to our general conditions of supply.