LANXESS
Energizing Chemistry

Polymer Testing for Rubbers, Rubber Compounds and Vulcanizates

Overview of Services and Prices
July 2008


Processing characteristics and final characteristics of elastomer products
(e.g., belts, dampers, tire treads)
Physical measurements performed on laboratory specimens
Polymer testing
Molecular modeling
Polymer physics
Microscopic structure: configuration, sequence monomer content
Macroscopic structure: molecular weight, dispersion, branching
Cross-link structure: number, order, structure of crosslinks
Phase morphology: filler dispersion, type and strength of interaction

Experience – Expertise – Safety: LANXESS Polymer Testing

Decades of success

The Polymer Testing laboratories within the LANXESS Technical Rubber Products (TRP) business unit are the product of many years of work and experience accumulated over decades at the former Bayer Rubber Testing Department.

We perform comprehensive testing and characterization of both raw polymers and finished compounds and vulcanizates. In addition, we have at our disposal the necessary equipment and experience for compounding and vulcanizing rubber.

Our range of services

Polymer Testing at LANXESS TRP is a successful international service provider for the rubber production and processing industries. We have enjoyed decades of successful collaboration with what is now the LANXESS Technical Rubber Products business unit, where our testing services help to improve existing products and to develop new products with improved characteristics. We also support the Technical Marketing function in their development and optimization projects with customers. TRP's production plants also use our services in order to safeguard the quality and uniform standards of their products.

Our expertise: finding the right mix for your success

From Raw Materials to Processing Testing – We Test Your Rubber

Not just a laboratory

As well as our comprehensive range of standardized laboratory procedures, we also offer our customers use of the facilities of the LANXESS Technical Rubber Products Technical Center. These facilities include a 90-liter internal mixer, an extruder for continuous UHF and salt bath vulcanization of profiles and injection molding machines.

While our range of services is aimed specifically at smaller and medium-sized companies in the rubber industry, our customers also include specialized business units of major rubber production and processing companies.

The advantage for you

Our team of specially trained mixing and testing technicians will ensure that the tests commissioned are performed in a reproducible and expert manner. Our experienced physicists, chemists, engineers and rubber technologists will advise you on the most appropriate test and measurement methods for your particular needs. On request, we will of course also support our customers in evaluating and interpreting the measurement data.

In addition to the standardized characterization of polymers, compounds and vulcanizates, we offer more advanced physical analysis of polymer materials with the aim of establishing a quantitative, empirical link between the technological properties and structural parameters of polymers and compounds. In this way, we create a sound basis for targeted development and optimization.

Not only does LANXESS Polymer Testing possess a wide range of testing capabilities, it also has the necessary expertise to describe in detail and to interpret measurement results in the context of physical observations.

Based on DIN EN ISO 9001 certification, all our measurements and analyses meet the high international quality standards recognized within the rubber industry and the stringent guidelines of an extremely wide range of industrial consumers.

Our expertise: customized tests and test specimens

Our services in detail

Our catalog of services is divided into seven sections, covering the typical requirements of our customers.
These include methods for making and handling compounds (1–3), followed by the various test procedures (4–6). The polymer physics service completes our portfolio of competences.

1. **Compounding**
2. **Processing compounds (extrusion, injection molding)**
3. **Storage, aging and swelling of test specimens**
4. **Static tests on rubbers, compounds and vulcanizates**
5. **Dynamic tests on rubbers, compounds and vulcanizates**
6. **Other tests on raw polymers, compounds and vulcanizates**
7. **Polymer physics**

You can count on us!

The prices listed are guide prices per grade, including labor and excluding the cost of materials and value added tax as applicable. They are for standardized testing procedures in all cases. We will be happy to provide you with a detailed quotation.

Please contact us if there is anything you do not see in our catalog of services. We will be happy to provide you with a detailed individual quotation for special testing or compounding orders that are not included in this overview, as well as for conceptual design and consulting services.

Our expertise: testing rubber, compounds and vulcanizates

Faster optimization with polymer physics
The purpose of polymer physics is to use appropriate modeling techniques to interpret the properties of polymers, compounds and vulcanizates characterized in the laboratory and to establish a link between molecular and macroscopic properties in order to support the efficient development and optimization of elastomer products. Please contact us – we will be happy to advise you!

Example: master curve approach
The technique known as the master curve approach can be used to visualize the relationship between macroscopic material properties and microscopic or mesoscopic structural properties using examples.

Based on the principle of time-temperature equivalence, multiple time-dependent and/or frequency-dependent measurements of dynamic and mechanical moduli can be combined in one master curve. This enables the frequency range, limited by the equipment used to four to six frequency decades, to be expanded to up to 20 decades, thus making it possible to accomplish a full characterization of the dynamic and mechanical properties of polymers from the viscous flow range to the vitreous solidification range.

Analyzing dynamic and mechanical behavior with the aid of physical models (rouse, reptation, double reptation, etc.) permits quantitative characterization of molecular and mesoscopic properties. This can be applied, for example, to the arrangement and sequence of monomers, to chemical and physical crosslink density, molecular weight, molecular weight distribution, and branch structure.

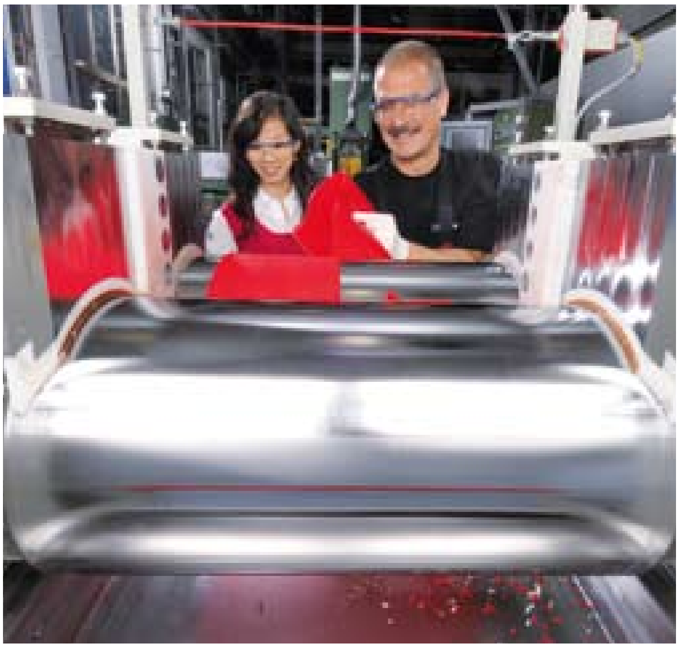
Example: amplitude-dependent characterization
Another important analytical process in polymer physics is the amplitude-dependent characterization of filled vulcanizates or compounds.

In addition, the shear modulus and elastic modulus of a filled rubber can be measured as a function of shear and strain amplitude at a constant temperature and frequency.

The change in amplitude-dependent dynamic and mechanical properties can be explained and quantified in physical terms by mechanically unstable filler-filler or filler-polymer interactions.

Example: non-linear mechanical properties
Non-linear mechanical properties can also be analyzed and interpreted on the basis of physical methods. For example, both the mechanically effective crosslink density of filled and unfilled polymers and the degree to which strengthening can be achieved using fillers can be determined by analyzing stress-strain behavior.

For the physical evaluation of other non-linear properties such as dynamic crack growth or durability, we offer special measurement methods. For example, we have developed a device called the “tear analyzer” which is available for conducting tests of this type.



Our expertise: processability tests

Our expertise: dynamic and mechanical characterization

LANXESS Polymer Testing Services and Prices
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1. Mixing procedures

Procedure	Denomination	Description	Standard	Costs[1] in EUR
Internal mixer 90 l	GK 90 E	Mixing including batch-off finishing	In-house procedure	1070
Internal mixer 5 l	GK 5 E	Mixing		325
Internal mixer 1.8 l	Farrel-Shaw	Mixing		185
Internal mixer 1.5 l	GK 1.5 E	Mixing		185
Internal mixer 350 ml	Brabender	Mixing		125
Internal mixer 85 ml	Brabender	Mixing		125
Microcompounder 15 ml	DSM	Twin screw mixing and sample preparation		85
Sheet forming test	Various sizes	Processing test on a mill		120
Mill	Various sizes	Mixing		90–200
Vulcanization	Steam- and electrically heated	Curing of slabs and samples		60

[1] All prices are estimated costs per compound including working hours without material costs; please ask for a detailed quote.

2. Processing of compounds

Procedure	Denomination	Description	Standard	Costs[1] in EUR
90 mm vacuum extruder	Berstorff L/D = 20	Continuous extrusion of hoses and profiles (incl. vulcanization in microwave channel or liquid salt bath)	In-house procedure	460
Injection molding test	Desma	Characterization of mold fouling and injection faults		230
Extrusion test	16mm Brabender Measuring Extruder L/D = 10	Processability of rubber compounds		160
Extrusion test	45mm Troester Measuring Extruder L/D = 10	Processability of rubber compounds		645

[1] All prices are estimated costs per hour including working hours without material costs; please ask for a detailed quote.

3. Aging and swelling tests

Aging in	Description	Standard	Costs[2] in EUR
Chemicals	Aging/swelling	Aging: DIN 53508, ISO 188, ASTM D 573 Swelling: DIN 53521, ISO 1817, ASTM D 471	30
Steam	Steam aging		80
Hot air	Hot air aging		10
Post-cure			10

[2] All prices are estimated costs per compound; please ask for a detailed quote.

4. Static test procedures

Test procedure	For [1]	Instrument producer	Description	Standard	Costs[2] in EUR
Cold flow test	P	Lanxess	Polymer flow in orifice at 50 °C	In-house procedure	55
Defo – New	P, C	Haake	Viscosity and elasticity of uncured materials	DIN 53514 (small sample)	185
Stress relaxation in compression	P, C, V	Lanxess	Decay of stress under constant compression	DIN 53537	295
Stress relaxation in tension	P, C, V	Lanxess	Decay of stress under constant elongation	ISO 6914	265
Compression set	V	Lanxess	Remaining deformation after a period of compression	DIN ISO 815 VW-3307 DBL-5555 ASTM D 395	35
Shore hardness	V	Barreis	Resistance against indention of a defined cone	DIN 53505 ASTM D 2240	25
Hardness (IRHD)	V	Zwick	Resistance against indention of a ball with a specific force	DIN 53519-1	35
Microhardness (µ-IRHD)	V	Zwick	Resistance against indention of a ball with a specific force	DIN 53519-2	55
Compressive stiffness (foam) (room temperature)	V	Zwick	Compressive deflection stiffness (at 40%)	DIN EN ISO 3386-1	100
Compressive stiffness (foam) (other temperature)	V	Zwick	Compressive deflection stiffness (at 40%)	DIN EN ISO 3386-2	100
Crystallization	P, C, V	Barreis	Change of hardness with time (Shore A) by crystallization	DIN 53541	190
TR test (temperature retraction)	V	Gibitre	Retraction of strained elastomer samples with temperature	ISO 2921	145
Adhesion to fabric (room temperature)	V	Zwick	Adhesion between fabric and elastomer layers	DIN 53530	100
Adhesion to fabric (other temperature)	V	Zwick	Adhesion between fabric and elastomer layers	DIN 53531-1	100
Tear test	V	Zwick	Resistance of various sample shapes against tear	DIN 53506, DIN 53507, DIN 53515, DIN 53539, ASTM D 470, ASTM D 624, in-house specification	100
Tension set	V	Zwick, Instron	Remaining deformation after storage under constant elongation	DIN ISO 2285 ASTM D 470	195
Tensile test, ring	V	Zwick, Instron	Stress-strain behavior, ultimate elongation and maximum stress under elongation	DIN 53504, ASTM D 412	100
Tensile test, dumbbell					40
Tensile test, dumbbell, elevated temperature					80
Greenstrength Tensile test, dumbbell	P, C	Zwick, Instron	Stress-strain behavior, ultimate elongation and maximum stress under elongation	DIN 53504 (except cross head speed 1000 mm/min), ASTM D 6746	185

[1] Polymers (P), Compounds (C) and/or Vulcanisates (V).
[2] All prices are estimated costs per compound; please ask for a detailed quote.

5. Dynamic test procedures

Test Procedure	For[1]	Instrument producer	Description	Standard	Costs[2] in EUR
High-pressure capillary rheometer	P, C	Göttfert	Shear stress and viscosity in dependence on the shear rate	In-house procedure	280
Melt flow index	P, C	Göttfert, Tinius-Olsen	Flowability of polymers at defined temperature and pressure	DIN EN ISO 1133	65
Mooney (viscosity)	P, C	Alpha Technologies	Viscosity of uncured materials	ASTM D 1646	30
Mooney (scorch)	P, C	Alpha Technologies	Scorch behavior of unvulcanized compounds	DIN 53523-4	95
Rheovulcameter	C	Göttefert	Simulation of injection molding	In-house procedure	50
Curemeter (MDR)	P, C	Alpha Technologies	Curing behavior	ASTM D 5289	70
Temperature-dependent modulus and phase angle					
–150 °C to 400 °C	V	Mettler DMA/ SDTA 861e	Temperature-dependent viscoelastic properties (f = const., γ and τ = const., sinusoidal mode) under various load conditions	Similar to DIN-ISO 6721	245
–100 °C to 150 °C	V	ARES			275
–100 °C to 160 °C	V	Eplexor			245
T = const.	V	Eplexor			80
–180 °C to 150 °C	V	Brabender torsion pendulum	Temperature-dependent viscoelastic properties (f ≠ const., free torsional oscillation)	DIN-ISO 6721	250
Gehman	V	Elastocon	Low temperature stiffening using a torsional wire apparatus	ISO 1432, ASTM D 1053	90
Frequency-dependent modulus and phase angle					
0,1 Hz to 30 Hz	P, C	Alpha Technologies RPA 2000	Frequency-dependent viscoelastic properties (T = const., γ and τ = const., sinusoidal mode) under various load conditions	In-house specification	75
0,01 Hz to 1000 Hz	P, C, V	Mettler DMA/ SDTA 861e			
0,001 Hz to 100 Hz	P, C, V	Paar-Physica MCR 300			
0,1 Hz to 500 Hz	V	MTS 831 Elastomer Test System	Frequency-dependent viscoelastic properties (T = const., γ and τ = const., sinusoidal mode)	In-house specification	130
Stress relaxation in compression	V	Elastocon	Time-dependent stress relaxation	In-house specification	295
Creep test	P, C, V	Paar-Physica MCR 300	Time-dependent viscoelastic properties (T = const., τ = constant)	In-house specification	280
Master curve construction	P, C, V	-	Combination of temperature and time-dependent measurements and application of the time-temperature equivalence	In-house specification	735
Distribution of molar mass (dynamic-mechanic)	P	-	Evaluation of the distribution of the molar mass from master curves	In-house specification	1250
Amplitude-dependent modulus and phase angle					
	P, C	Alpha Technologies RPA 2000	Amplitude-dependent viscoelastic properties (T = const., f = const., sinusoidal mode)	In-house specification	60
	V	MTS 831 Elastomer Test System		In-house specification	130
	V		As above, but pulsed deflection mode	In-house specification	140

[1] Polymers (P), Compounds (C) and/or Vulcanisates (V).
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Test Procedure	For[1]	Instrument producer	Description	Standard	Costs[2] in EUR
Rebound resilience	V	Lanxess	Relative rebound height of a pendulum	DIN 53512	100
Brittleness point	V	Gibitre, Gotech	Estimation of the brittleness temperature	DIN 53546, ASTM D 746, ASTM D 2137, DIN-ISO 812	450
Abrasion	V	Zwick, Barreis	Resistance against wear on a rotating drum	DIN 53516, ASTM D 5963	80
Pico abrasion	V	Ferry/ BF Goodrich	Resistance to abrasive wear	In-house specification ASTM D 2228	100
Akron abrasion	V	-	Resistance to abrasive wear	In-house specification	100
Sliding friction	V	Lanxess	Coefficient of friction between rubber and other surfaces	In-house specification	210
Skid resistance	V	BPSR tester		In-house specification	235
Grosch wet skid test	V	LAT 100 VMI	Resistance against rolling and slipping	In-house specification	350
Goodrich flexometer	V	BF Goodrich	Heat built up, fatigue life and creep under sinusoidal compressive load	DIN 53533	290
Fatigue to failure test	V	Monsanto	Fatigue life under cyclic elongation	In-house specification	730
De Mattia fatigue life	V	Zwick	Fatigue under cyclic bending deformation	DIN 53522	150
De Mattia crack growth	V	Zwick		DIN 53522	150
Tear analyser	V	Coesfeld	Crack propagation rate under pulsed or sinusoida elongation	In-house specification	320

[1] Polymers (P), Compounds (C) and/or Vulcanisates (V).
[2] All prices are estimated costs per compound; please ask for a detailed quote.

6. Other test procedures

Test Procedure	For[1]	Instrument producer	Description	Standard	Costs[2] in EUR
Cord adhesion test	V	-	Separation force between cord and rubber	ASTM D 2229	200
				In-house test specification	200
DBP absorption	-	-	Determination of the structure of fillers	DIN 53601	80
Density	P	Elatest	Density measurement by compression with a piston	Manufacturer's instructions	50
	C				
	P, C, V	Copied from Archimedes	Weighing of specimens in air and water	DIN 53479	35
Filler dispersion	V	Dispergrader	Optical (magnification x100) evaluation and comparison of cut surfaces with reference pictures	Procedure of the supplier	85
Humidity	P	-	Mass loss during storage in exsiccator over drying agent	In-house specification	75
Volatile matter	P	-	Content (mass %) of volatile ingredients in rubber sheets	Similar to DIN 53526	65
Gas permeation	V	-	Permeation coefficients as a function of temperature and test gas	DIN 53536	540
HCL formation	P, C, V	-	Temperature-dependent formation of HCL from chloroprene rubber	EN ISO 305 (Congo red indicator paper)	45
Cold bending test	V	-	Embrittlement of elastomers/bending test around a rod (–70 °C to 10 °C)	In-house specification	120
Fuel permeability	V	-	Amount of fuel migrating through a rubber membrane as a function of time	DIN 53532	270
Solubility	P, C	-	Check for undissolved particles after shaking in a suitable solvent	In-house specification	40
Swelling test	P, C, V	According to Archimedes	Mass and volume change after swelling in liquids	DIN 53521	65
Ozone crack test, dynamic	V	-	Crack development on the surface of strained elastomers when stored in ozonized air	DIN 53509 and ISO 1431	230
Ozone crack test, static	V	-			
Xenon light resistance	V	Heraeus	Treatment with light, with a spectral energy distribution similar to sunlight	DIN EN ISO 4892-2	85
Calorimetry	–	–		In-house specification	125

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