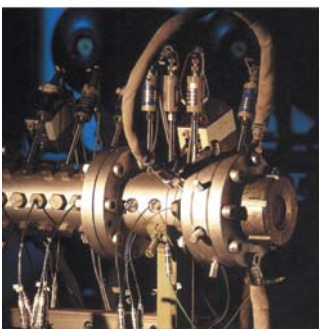
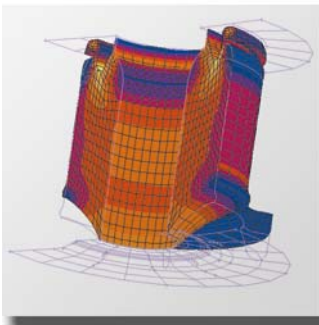




DEUTSCHES INSTITUT FÜR KAUSCHUKTECHNOLOGIE E. V.



List of instrumentation

Contents

CONTENTS	2
SPECTROSCOPY AND CHROMATOGRAPHY	3
1. Spectrometry	3
2. Gaschromatography, Mass Spectrometry	3
3. Nitrosamine analysis	3
4. Liquid Chromatography	3
5. Gel Permeation Chromatography (GPC)	4
6. Thin Layer Chromatography	4
7. Chemiluminescence	4
MICROSCOPY	4
1. Light Microscopy.....	4
2. Transmission Electron Microscopy	5
3. Atomic Force Microscopy (AFM) and Topography Messurment Systems	5
4. Computertomography.....	5
5. Scanning electron microscopy (SEM).....	5
6. Thermo analyses	6
7. Thermographic Analyses.....	6
8. Nuclear Magnetic Resonance Spectrometry (NMR).....	6
PROCESSING	7
1. Mixing	7
2. Extrusion.....	7
3. Injection Moulding.....	8
4. Calendering	8
5. Vulcanization	9
6. Plasmapolymerisation and activation Instrument.....	9
PHYSICAL AND DYNAMIC MECHANICAL PROPERTIES	9
1. Physical Testing	9
2. Dynamic Mechanical Properties	10
3. Dielectric Properties	10
4. Tribological properties	11
RHEOLOGY UND RHEOMETRY	11
1. Rheology	11
2. Rheometry.....	12

Spectroscopy and Chromatography

1. SPECTROMETRY

- Qualitative and quantitative analyses of polymers and additives,
- Physical chemical characterizations,
- Analyses of extracts,
- Measurements of diffusion coefficients,
- Failure analyses,
- Quality assurance,
- Trace analyses,
- Characterization of contact layers.

Fourier-Transform-Infrared-Spectrometer (FT-IR)

Thermo Nicolet Nexus, attenuated total reflection (diamante- or germanium ATR), micro scale IR spectrometry.

FT-IR-Microscopy

Thermo Nicolet Continuum, imaging system for documentation.

UV/VIS-Spectrometer

Kontron Ultraviolet Uvikon 810, photometric measurements, detection system for HPLC.

2. GASCHROMATOGRAPHY, MASS SPECTROMETRY

- Separation of multi component mixture (extracts, additives, fumes, emissions)
- Identification and quantitative determination of components in extracts , vulcanization fumes etc.,
- Determination of compatibility of rubbers and solubility parameters,
- Thermodynamic Characterization of polymers and fillers by means of „Inverse“ Gas Chromatography,
- Identification of polymers (Pyrolysis -GC).

Gas Chromatographs

Fisons Instruments,
Agilent GC-5890.

Injection Systems

Agilent, Autoinjector 7683, on column, Split/Splitless, Headspace-Technique, Autosampler.

Detectors

FID, NPD.

Gas Chromatography-Mass Spectrometry (GC-MS)

Agilent, GC 6890N/MSD 5973N/7683,

Agilent, GC 6890 N/MDS 5975c/7683

Mass spectrometer: Quadrupole, Chemical Ionization, Electron Impact Ionization, Split/Splitless-Injector, Head-Space Autosampler HP.

Thermodesorption

Gerstel TDS 3

N₂ (liquid) cryo-cooling (-150...+400 °C), Peltier-cooling UPC (10...400 °C), Heating rate max. 60 °C/min, Split/Splitless-Injector; Gerstel KAS 4, Controller 505, Pyrolysis Modul PM 1.

3. NITROSAMINE ANALYSIS

- Nitrosamine determination in air (workplaces), in vulcanizates, uncured rubbers and in fillers.

GC/TEA-Coupling (Nitrosamine Analysis)

3 Instruments: Carlo Erba GC-Vega 6000, Varian 3400, Agilent 6890N equipped with Isconlab-Thermal Electron Analyzer (TEA), Autosampler Fisons Instr. A 200S and CE Instruments AS 800.

4. LIQUID CHROMATOGRAPHY

- Qualitative and quantitative analyses of high boiling or thermal unstable components (like oils, extracts, plasticizers, antioxidants, crosslinking chemicals),
- Trace analyses on polymeric materials (leachables).

High Pressure Liquid Chromatography (HPLC)

Kontron 420, isocratic pump system,
2 x Thermo Separation Products P2000, gradient pump systems with Autosampler AS 1000.

Detector systems

UV/VIS Detektor (G1314A), Refractometer (RI, G1362A), Photodiodenarray-Plus-Detector (Surveyor).

Liquid Chromatography-Mass Spectrometry (HPLC-PDA-MS)

ThermoFisher LCQ-System (Surveyor), Photodiodes Array Detector (PDA-Plus-Detector, Surveyor), Atmospheric Pressure Chemical Ionization (APCI), Electro spray ionization (ESI), Ion Trap with MS-MS-Technique.

5. GEL PERMEATION CHROMATOGRAPHY (GPC)

- Separation of solved polymers according to the size exclusion principle,
- Determination of relative mol masses,
- Determination of mol mass dispersions.

GPC-Instruments:

Agilent 1100 Isocratic Pumpe (G1310A), Autosampler (G1313A), UV/VIS Detektor (G1314A), Refractometer (RI, G1362A), Light Scattering Detector (SLD 7000).

Detection systems

UV/VIS Detektor (G1314A), Refractometer (RI, G1362A), Light Scattering Detector (SLD 7000).

6. THIN LAYER CHROMATOGRAPHY

- Separation of multi component liquids,
- Qualitative Analyses of extracts, plasticizers, accelerators and antioxidants.

7. CHEMILUMINESCENCE

- Characterization of the oxidative stability of polymers, oils, biological substances,
- Analysis of aging behavior of polymers,
- Characterization of the efficiency of antioxidants.

Chemiluminescence-Analyser

Chemilume™ CL400 (Atlas)

4 gase tightend test cells with separate control of temperature, of gas flow, of testing time and of photomultiplier -amplification; isothermal and programmed -temperature up to 250 °C; Gas flow: 25 ml/min or 50 ml/min; optical sensitivity: $8,2 \times 10^{10}$ V/Lumen; 2 Counts/s.

Microscopy

1. LIGHT MICROSCOPY

- Failure analyses,
- Morphology of blends,
- Filler dispersion,
- Filler distribution.

Light microscope with phase contrast

Zeiss Universal, Magnification: max. 2000x, Phase Contrast.

Stereomicroscope

Zeiss 9901; Magnification max. 100x.

Light microscope (transmission and reflectance technique)

Jena Jenaval/Jenavert, Magnification max. 1250x.

Dispersion Index Analysis System (DIAS)

Computer-based reflectance-light microscopic determination of filler dispersion and the distribution of the agglomerate size on elastomer surfaces at a magnification of 150x. Software developed by the DIK based on a SIS-picture analyzing program.

2. TRANSMISSION ELECTRON MICROSCOPY

- Phase morphology of polymer blends,
- Network inhomogeneities,
- Carbon black dispersion and -distribution,
- Polymer/plasticizer systems,
- Particle characterization,
- Measurements on elastomer parts under defined strain,
- Failure analysis.

Transmission electron microscop

LIBRA[®] 120 (Zeiss)

Acceleration voltage 120kV, Köhler illumination, magnification 8x...630000, point resolution 0,34 nm, Electron Spectroscopic Imaging (ESI); Electron Spectroscopic Diffraction (ESD), element or structure contrast reproduction, electron energy loss spectroscopy (EELS) for chemical analysis, cryogenic table, image processing.

Ultramicrotomy

Preparation of ultra thin cuts by using glas cutters (80...150 nm) or diamant cutters (50...100 nm), Semi thin cuts using glas cutters (max. 1 mm), Operating temperature: -160...+20 °C, cryo transfer system for cryo fixed samples.

-Reichert FC-4E Ultramicrotome;

-Leica Ultramicrotome UC6 with liquid nitrogen cutting system FC6, equipped with stereo microscope MZ6.

3. ATOMIC FORCE MICROSCOPY (AFM) AND TOPOGRAPHY MESSURMENT SYSTEMS

- Surface roughness,
- Phase morphology of polymer blends,
- Filler distribution,
- Filler dispersion,
- Magnetic properties.

Atomic Force Microscope

2 AFM devices: Topometrix Explorer 2000 and FRT-AFM MicroProf 100

Imaging procedure: contact mode, non-contact mode, very high resolution in nm range.

Contrast procedure: topography, friction force detection, detection of hardness variation by force modulation, force-distance curves, magnetic force detection.

Chromatic topography measuring system FRT-CWL 300.

Contact-free measurement of the surface topography, lateral resolution <2 µm, vertical resolution 3nm, max height difference 4 mm, max image area ca 100x100 mm.

4. COMPUTERTOMOGRAPHY

- Analysis of insertions, defects,
- Dispersion analysys, fillers and crosslinking chemicals (ZnO etc),
- Analysis of crack initiation and propagation,
- Cell structure analysis,
- Testing of rubber-metal and rubber-plastic bonding,
- Location of reinforcement and fiber orientation,
- Non destructive defect analysis,
- Dimensional measurements.

Nanotom[®]; 180kV/15W nanofocus-Computertomograph

GE phoenix x-ray, 180kV/15W high power nanofocus tube. 5 megapixel fully digital detector.

Maximum sample dimensions 150x120x120 mm (height x width x thickness).

Best resolution (sample size dependent) 500 nm in 3D.

Image processing software for 3D representation and quantitative analysis (particle size distribution).

5. SCANNING ELECTRON MICROSCOPY (SEM)

- SEM-pictures, BSE- pictures,
- Elementidentification,
- Element quantification and -distribution,
- Surface structures,
- Material contrasts.

Scanning electron microscope

EVO MA10, W-Filament, 0,2-30 kV, Magnification: 7x...1000000x, Variable Pressure 10 - 400 Pa, SE-Detector, BSE-Detector, EDX-Detector. (Si/Li-crystal); max. sample height: 100 mm.

EDX

Oxford Instruments INCA (EDS8100)

6. THERMO ANALYSES

- Quantitative composition of elastomers (polymer, plasticizer, carbon black, anorganic fillers, soot),
- Determination of glass transition temperatures, of melting point in thermoplastis, rubbers and elastomers,
- Morphology of blends,
- Heat capacity,
- Kinetics of blowing aids and crosslinking chemicals.

Thermogravimetry (TGA)

TA-Instruments TGA 2950CE-Hi-Res, sample mass: max. 1 g, Temperature range: 25...1000 °C, heating rate: 0,1...200 K/min, Evaluation: PC/Software.

Netzsch TG 209 F1, sample mass: max. 2 g, Temperature range: 20...1000 °C, Heating rate: 0,001...80 K/min, Evaluation: PC/Software.

Differential Scanning Calorimetry (DSC)

TA-Instruments DSC 2920CE, modulated DDK-MDSC, sample mass: 0,5...100 mg, temperature range: –180...+725 °C, heating rate: 0,01...200 K/min linear and 0,01...10 K/min modulated, evaluation: PC/Software-Standard/Kinetic.

Netzsch DSC 204 F1, Temperature range: –180...+700 °C, heating rate: 0,0001...100 K/min, evaluation: PC/Software.

VCI - Fire Simulation Equipment

Analytik Jena GmbH, Temperature range up to 1200 °C.

Fogging Test Equipment

Determination of Fogging-values

Instrument: Heating and cooling device, test chamber acc. to DIN 75 201-B.

7. THERMOGRAPHIC ANALYSES

- Quality control,
- Heat loss determination,
- Improvement of processes.

Rapid Realtime Thermography Camera:

VarioTHERM, InfraTec GmbH

Measurement of points and areas with editable emission value, possibility to dub in of Isotherm, Peak-Hold-Function. Spectral range 3,6...5 µm; recording method 'Focal Plane Array'; PtSi-CMOS-Hybrid Detector, 50 Hz Image frequency; Temperature solution (30 °C): <0,1 (0,01 mA); temperature range : –25...+1200 °C; geometrical solution: 1,0 mrad; field of view with standard-optic: 14 × 14°; size of image: 256 × 256 Pixel; signal digitization: 16 Bit; working temperature: –15...+50 °C; data output: PAL-FBAS, Y/C.

8. NUCLEAR MAGNETIC RESONANCE SPECTROMETRY (NMR)

- Characterization of polymer chain dynamic properties,
- T₁ and T₂- relaxation time determination,
- Correlation T₂-value - crosslink density,
- Aging of polymers (in situ aging).

Instrument:

XLDS-15, Innovative Imaging Corp. KG, 0,35 T = 15 MHz, 20 -120 °C, solid state spectroscopy

Processing

1. MIXING

Internal Mixers

Werner & Pfleiderer GK5E/GK4N

GK5E: intermeshing rotor system with PES-3-rotor, useful volume 5l, ram 1...7 bar, infinitely variable, rotation of blade 17...100 rpm.

GK4N: tangential rotor system in standard or n-geometry, useful volume ~3,6l, ram pressure 1...6 bar, infinitely variable; friction 1 : 1 to 1 : 1,3 rotation of blade 22...135 rpm.

GK5E und GK4N: cooling by water for mixing chamber and, temperature-controlled until 95°C, process control by time, specific energy, temperature; measured value acquisition.

Internal Mixer

Werner & Pfleiderer GK 1,5 E

Useful volume ~1l, cooling until 95°C

Two-Roll Mills

Berstorff 250 * 500

Mills diameter 250mm, mills length 500mm, drive via 2 x dc motors, batch size ~6dm³, rotation 1...25rpm; continuous oil-cooling, apparatus with 10 knives of cutter bar, measurement of flow and return temperature of the heating-cooling circuits, die gap at the end of the mills, 2 x torque, bearing reaction of the fixed mill, 5 x measurements of the melt pressure of the , 2 x rotation.

Berstorff 150 * 350 RR

Diameter of mills 150mm, length of mills 350mm, cooling until 100°C.

2. EXTRUSION

Pin-Barrel Extruder

Krupp KGS 60/14; 60 mm, 14D

Screw diameter 60mm, screw length 14D, drive via dc motor; rotation 7...70rpm, throughput ~100...200kg/h, separate heating-cooling circuits for the feed roll, screw and 3 cylinder zones, measurement of input power, speed, mixture temperature radial per 4x in 3 pin extrusion and 8x in front of the screw tip, axial pressure curve in 7 levels, extrudate diameter. Remodelling of the extruder and reduction of 10D allows the application as processability tester for rubber mixtures, continuous process data acquisition.

Transfermix Extruder

AZ MCTM 60

Screw diameter 60mm, variable screw length 11 D to 13,7D with 1 or 2 transfer mixing zones, drive via dc motor rotation up to 205rpm, throughput ~100 ... 200kg/h, separate heating-cooling circuits for screw and 2 cylinder zones, measurement of input power, rotation as soon as melt temperature and melt pressure in front of the gap tip, pressure in each case after the transfer mixing zones, continuous process data acquisition.

Laboratory Extruder

Rubicon EEK 32.12 S-4,0/90

Screw diameter 32mm, screw length 12D, input power 4KW three-phases asynchronous motor, screw rotation 3...90rpm, throughput ~1...25kg/h, separate heating-cooling circuits for screw and cylinder, cooled up to 250°C, access line at gear pump MAAG Enhex SP 21-4, application as extruder-gear pump-combination or anytime for metering of rubber or rubber mixture into the twin screw extruder Berstorff ZE 25, pre-printed form control over control of the gear, measurement of the rotation, melt temperature, melt pressure.

Twin Screw Extruders

Berstorff ZE25, 10,5 kW, Nmax = 550 U/min, screw diameter 25 mm, screw length until 54 L/D, cylinder segment in 6D, Barbender-Flex-Wall main metering, gravimetric Brabender metering with side-way feeding, vacuum cylinder, fluid injection, powered shaft extractor for the screw to process optimisation and sampling (e. g. morphological investigation).

Twin Screw Extruders

Berstorff ZE 40 A UTX; 44mm, screw length 55 L/D cylinder segments until 6D, temperature and pressure measuring stations, gravimetric Brabender-Flex-Wall main metering, gravimetric Brabender metering with side-way feeding, fluid injection. Metering of the extrudate with rubber or rubber mixture in feeding strips over a single-screw extruder-gear pump-combination (transfer mixing extruder AZ MCTM 60, gear pump Troester ZP 56/33). Continuous producing of rubber mixture and thermoplastic vulcanisates.

Fully automatic process data acquisition for the simultaneous, continuous acceptance of the process data of the gravimetric dosing feeder, twin-screw extruder, single-screw extruder and the gear pump Troester ZP 56/35.

Dosing System

Mahr; metering of fluids into the twin-screw extruder Berstorff ZE 25 across gear pump and Coriolis sensor; output 2-12 kg/h; metering accuracy +/-2%, temperature-controlled up to 60°C; viscosity range 200-2000 mPa·s.

Twin Screw Micro-Compounder

(DSM Explore 15 cm³ Micro-Compounder)

Twin-screw extruder with co-rotating conical screws, screw length 150mm, useful volume 12,5cm³, rotation 0...245rpm, temperature range 20...350°C, max. axial force 8000N, 6 heating zones, water cooling, by-pass valve (residence time adjustable), computer-aided carrying experimentation und data acquisition.

Granulation Unit

Pell-Tec SPP 50 compact; throughput 180 kg/h, 7...50 m/min, max. Strand No. 9, length 4m.

Gear Pumps

Troester ZP 56/35

Throughput 120 kg/h, back pressure 20bar, delivery pressure 500bar, max. differential pressure 450bar, max speed 48rpm, continuous process data acquisition.

MAAG Entrex SP 21-4

Throughput 2...10 kg/h, back pressure 20bar, delivery pressure 350bar, differential 250bar, max. speed 50rpm.

3. INJECTION MOULDING

Injection Moulding Machines

Klöckner Ferromatik Desma D 966.053ZO

Closing force 500kN, displaced volume 330cm³, max. screw temperature 150°C, max. mould temperature 499°C, max. injection pressure 2000bar.

Laboratory Injection Moulding Machine

DSM Explore 10cm³

Nominal volume 10cm³, injection part T_{max}=350°C, form T_{max}=200°C, pneumatic pressure 10...16bar (is equivalent up to 1600N), two-cylinder heating, form for S2 tensile bar, exchangeable.

Two Component Injection Moulding

Both injection units returnable for rubber or thermoplastic, possibility of 2K application: rubber/thermoplastic, rubber/rubber and thermoplastic/thermoplastic. Screw diameter 25mm, aggregate in I-position, without tie bars construction, closing force 800kN, 2-station turntable, control CC200. 2K in-mould assemblies as tensile bar and compression member with separate mould temperature control for the two components in the nozzle side and ejection side of the mould. Metal insert into the shear bar possible; pressure test in the mould for both components; data logging via control.

4. CALENDERING

- production of a flat film or sheet of uniform thickness (coating, double-sided coating, frictioning),
- calender feeding: discontinuous (rough sheet from a mill) and continuous from extruder (strip feed, throughput up to 200 kg/h),
- hot edge trim,
- take-off of sheet by center winder.

Four-roll laboratory standard calender

Troester KQF 200

Four-roll calender, inverted L-type: roll dia. 200 mm, face-width 450 mm, 350 mm of working width, edge trimmer on stripper roll, max. trimmed sheet width 320 mm, calender feeding in 1st or 3rd roll gap alternately, distance pieces in the 1st and 3rd roll gap, operating: four-rolls, three-rolls, or 2x2 rolls, circumferential speed for each roll separately 2,0...20 m/min, friction ratio from 1:1,25 up to 1,25:1, temperature for each roll separately up to 200 °C, electric roll adjustment, min. roll gap clearance 0,3 mm, pneumatic pre-load for 1st, 2nd and 3rd roll, roll crossing for 3rd roll.

Calender train: roller train, cooler (two cooling drums, dia. 300 mm each), winder.

Data Acquisition System: measurement of roll gap size, roll speed, axis load (1st and 2nd roll), gap pressure in the 1st and 2nd roll gap (three pressure sensors build in second calender roll), electric power.

Calender feeding by conveyor belt

Scholz

Infinitely variable speed and oscillation of the conveyor.

Calender train

DIK

Cooling section with two cooling drums – diameter 300mm, manual speed control.

5. VULCANIZATION**Vulcanization press****Rucks Maschinenbau KV 207.00**

Electrical heating: 250 × 250 mm

Wickert & Söhne WLP63/3,5/3

Electrical heating: 350 × 350 mm

Berstorff

Electrical heating: 300 × 350 mm

6. PLASMAPOLYMERISATION AND ACTIVATION INSTRUMENT

PlasmaTreat, PFW20

8 parallel plasma torches, plasma activation and plasma polymerization (PE-CVD) at atmospheric pressure, treatment of areas with a range of 5 – 50 mm, process speed 1 – 60 m/min.

Physical and Dynamic Mechanical Properties

1. PHYSICAL TESTING

- Determination of physical properties of vulcanized rubber (ISO, DIN and ASTM norms),
- Stress relaxation,
- Ageing behavior of vulcanized rubber,
- Heat resistance,
- Resistance to ozone cracking
- Resistance to light,
- Contact discoloration,
- Contact angle and surface energy.

Uniaxial Stress-Strain

Zwick 1445, max. force 5 kN, heating chamber (-60 - + 150 °C).

Zwick Z010, max. force 2,5 kN.

Biaxial Stress-Strain

Elastocon EB 02, Stress Relaxation in a temperature range of 10...200 °C, max. force 800 – 1600 N (stress), 70N (strain), measurements in Air, Nitrogen and Oil (ISO 3384).

Goodrich-Flexometer

Doli FlexoB 1170, frequency 30 Hz, tension ½ Mpa, heating up to 100 °C.

Fatigue to Failure Test (de Mattia)

Frank 13515, Determination of cracking speed and cracking growth resistance.

Frequency: 5 Hz.

DIN Abrasion Tests

Frank 11565, Testing of abrasion resistance.

Hardness

Zwick digitest, Shore A; Micro Hardness

Rebound Resilience

Frank 23267, Zwick 5109.01, with temperature control.

Electrical Resistivity

Dr. Kamphausen, Determination of surface resistance and conductance.

Ozone AgeingArgentox 3MR-3R, Temperature 0 - 70 °C, Specimen Room: 200 l, concentration O₃ 50 – 250 ppm (0.5 – 2.5 ppm), humidity 10 – 90 %.

Contact Angle Measurement

Dataphysics OCA20, temperature control system $-20 \dots +150 \text{ }^\circ\text{C}$, multiple dosage system, calculation of the free surface energy of solid materials and the surface tension of liquids.

Tensiometer and Dynamic Contact Angle Measurement

Dataphysics DCAT11, temperature control system ($-10 \dots +130 \text{ }^\circ\text{C}$), contact angle measurement on powder or fibres.

2. DYNAMIC MECHANICAL PROPERTIES

- Dynamic properties,
- Fatigue properties,
- High frequency properties (ultrasound),
- Elastic modulus, shear modulus, damping,
- Temperature, frequency and amplitude dependence,
- Standard and customer specific measurements,
- Dynamic crack propagation behaviour.

Tear Analyzer, dynamic crack propagation

Tear analyzer system Bayer-Coesfeld, crack propagation resistance under dynamic load. Optical online acquisition of the crack surface, energy recording. Calculation of fracture mechanics factors for lifetime predictions (tearing energies) up to 10 ms pulses, temperature controlled testing chamber in air or nitrogen environment.

Ultrasonic spectrometer (Prototype)

Measurement of the ultrasonic attenuation and sound velocity (enabling the calculation of the storage and loss moduli) using the transmission principle. Frequency range 0,5 MHz, 1MHz, 2MHz. Temperature range: coupling fluid dependent between -100°C and $+100^\circ\text{C}$.

Dynamic-mechanical thermal analyzer (DMTA)

Mettler Toledo DMA 861, tests in double shear sandwich geometry between -150°C 500°C and 0,001Hz-1000Hz, 0,01-5% amplitude.

Dynamic mechanical analyzer

Rheometrics RDA II, shear measurements on unvulcanized mixes (double plate geometry) and vulcanizates (strip samples) -150°C $+350^\circ\text{C}$ 0,002Hz 16Hz; 0,05... 5% amplitude.

ARES Rheometer system

Rheometrics Scientific, shear measurements on unvulcanized mixes (double plate geometry) and vulcanizates (strip samples) -150°C $+350^\circ\text{C}$ 0,002Hz 80Hz; 0,05 10% amplitude.

Dynamic mechanical Spectrometer

Rheometrics RSA II, Compression and tension tests $-150^\circ\text{C} \dots +500^\circ\text{C}$, 0,002Hz...16Hz, 0,01%...1% amplitude.

Servohydraulic Elastomer Testing System

MTS 831.50, Shear, compression and tension tests on specific dumbbells. $-120^\circ\text{C} \dots +200^\circ\text{C}$, 0,01Hz..1000Hz, 0,1...100% amplitude. Tests according to client specific requirements; dynamic and fatigue properties under rapid pulse load. Force range $\pm 5\text{ kN}$; displacement $\pm 25\text{ mm}$.

Biaxial Servohydraulic Elastomer Testing System

MTS 322.21, linear biaxial tests on specific dumbbells. Dynamic mechanical properties and fatigue properties.

1. Axis: 0,1...100Hz, $\pm 25 \text{ kN}$, $\pm 100 \text{ mm}$.

2. Axis: 0,1...150Hz, $\pm 10 \text{ kN}$, $\pm 50 \text{ mm}$.

Dynamic and fatigue properties under pulsed oscillations, force and displacement controlled.

3. DIELECTRIC PROPERTIES

Dielectric Broadband Analyzer

Novocontrol GmbH, Measurements on vulcanizates, mixtures and liquids.

BDS 40

Frequency range: $3 \times 10^{-5} \dots 2 \cdot 10^7 \text{ Hz}$

Impedance range: $10^{-2} \dots 10^{14} \Omega$

Capacity range: $10^{-15} \dots 1 \text{ F}$

Resolution ($\tan \delta$): 3×10^{-5}

BDS 60

Frequency range: $10^6 \dots 3 \times 10^9$ Hz

Impedance range: $10^{-1} \dots 10^5 \Omega$

Resolution ($\tan \delta$): 3×10^{-3}

Quatro Cryosystem Temperature Unit

Temperature range: $-160 \dots +400$ °C

Temperature resolution: 0,1 °C

4. TRIBOLOGICAL PROPERTIES

Tribometer

IMKT Construction; Measurements of the static and dynamic friction coefficient; Velocity range: 0,005 - 10 mm/s and 0,1 - 30 mm/s; Pressure range: 0,01 - 10 MPa; Temperature range: - 40 to +100 °C.

Rheology und Rheometry

1. RHEOLOGY

- Viscous and elastic properties of rubber mixtures,
- Mooney-Relaxation,
- Mooney-Scorch,
- Wall-slip behaviour.

Mooney-Viscometer

Alpha Technologies MV 2000 E

Measurement of mooney viscosity of rubber and rubber mixtures. Flexible data collection options.

Laboratory Extruder

Polylab-System

Measurement of the shear rate dependent viscosity by using different extrusion dies (e.g. flat slit, tube) with sensors for pressure and temperature.

Laboratory Internal Mixer

Polylab-System

Mixing of rubber compounds with simultaneous measurement of temperature and torque. Programable mixing intervals for temperature and rotary speed.

Chamber Volume: 70 cm^3 and 350 cm^3 .

Rotational-Rheometer

Physica MCR 501 S, Anton Paar

Maximum Torque 300 mNm, Normal forces -70 to 70 N. Various measurement geometries: plate-plate, cone-plate for measurements of the normal stress coefficient. rotational - and oscillating measurements. Possibility of combining rheological and dielectric or magnetic measurements.

Dielectric sample cell: Temperature range: -25° to 180° C. Dielectric Broadband Analyzer by Novocontrol

Frequency range: $3 \cdot 10^{-5}$ to 10^7 Hz.

Magnetic sample cell: Temperature range: -10° to 180° C. Maximum magnetic field strength of 1 T.

High Pressure Capillary Viscometer

Göttfert Rheograph 6000

two methods of measurement: constant shear rate, constant shear, maximum shear: 2×10^6 Pa, shear rate 2×10^{-2} - $2 \times 10^6 \text{ s}^{-1}$

capillary diameter 0,5 - 4 mm, capillary length 5 - 120 mm; special capillaries with sensors for pressure and temperature (also as slit capillary), measurement of shear and viscosity in dependency of shear rate, determination of flow anomalies (e. g. wall-slip); determination of swell profile, data collection of the pressure profiles; collection of the pressure profile along the capillary.

Rosand RH 7-2, two capillary system

Capillaries with different length/diameter ratios for measuring the shear rate dependency of the viscosity.

Dynamic data range 50000 : 1 in a temperature range of 50 - 400 °C.

Ubbelohde-Viscosimeter

Visco System® AVS 370 (SCHOTT Instruments)

Determination of Staudinger index and mol mass; max. 5 dilution steps. Determination of kinematic viscosity.

Measurement range: 0,35 ... 5000mm²/s. Data acquisition, evaluation of data: PC, Software.

Rubber Process Analyzer

Alpha Technologies RPA 2000

The RPA measures the viscoelastic properties of polymers and elastomeric compounds providing comprehensive data on key parameters such as:

- Process ability,
- Cure characteristic,
- Final cured properties.

Temperature range: 40 - 250 °C, oscillation strain 0,5 - 150 %, oscillation frequency 0,1 - 33 Hz.

2. RHEOMETRY

- curing kinetics,
- activation energy,
- incubation behaviour.

Rheometer

Alpha Technologies MDR 2000 E

rotorless, variable operating points, torque- and loss angle measurement.

Update: April 2009



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