Dynamic Shear Rheometers for Asphalt
The requirements for asphalt binder and bitumen, especially with regards to their elasticity and flexibility, have increased significantly in recent years. Particularly in road construction, new asphalt concepts are being constantly developed to withstand the heavy strains caused by the ever-increasing traffic volume. However, traditional test methods are often not sufficient to characterize these innovative and mainly polymer-modified materials.

So that modern asphalt and bitumen products meet the high requirements placed on them there is a need for high-performance instruments to investigate and analyze these products in both quality control and during product development. The SmartPave 92 and SmartPave 102 dynamic shear rheometers are able to analyze unmodified as well as modified asphalt binder and bitumen in a wide temperature range, either according to standards or with classic rheological methods.

Anton Paar dynamic shear rheometers have proven themselves worldwide for decades due to numerous innovative technologies like the EC motor, the Toolmaster™ automatic tool recognition system, and the most accurate Peltier temperature control for dry sample thermostatting available. This guarantees unrivalled accuracy, convenience, and ease of use in asphalt and bitumen rheology.
Asphalt and bitumen testing

Asphalt binder and bitumen testing with the SmartPave series:

Superpave performance grading according to AASHTO T315 / ASTM D7175

Classify asphalt binders relative to their rated performance in a temperature range from 6 °C to 88 °C related to the conditions under which they are used, including environmental conditions and pavement temperatures.

Viscosity determination of asphalt binder according to AASHTO T316 / ASTM D4402 / DIN EN 13702

Use standard testing methods for viscosity determination of asphalt binder with a rotational viscometer/rheometer to research the processability of asphalt binders in a temperature range from 60 °C to 200 °C.

Rheological property determination of GTR-modified (ground tire rubber) asphalt binders (AASHTO draft)

Asphalt binders can be blended with ground tire rubber (GTR) to beneficially modify the properties of the pavement in highway construction. Determine the temperature-dependent rheological properties in an appropriate temperature range with a special DSR setup based on a concentric cylinder Peltier-controlled temperature device.

The dynamic shear rheometers (DSR) from Anton Paar are especially designed for the needs and demands of the asphalt industry.

All relevant asphalt binder and bitumen standards can be covered with SmartPave 92, SmartPave 102, and MCR 502S.

Multiple stress creep recovery (MSCR) according to AASHTO T350 / ASTM D7405 / DIN EN 16659

Determine the rutting performance of modified asphalt binder by measuring the percent recovery and non-recoverable creep compliance of modified asphalt binders.

Rheological property determination of GTR-modified (ground tire rubber) asphalt binders (AASHTO draft)

Asphalt binders can be blended with ground tire rubber (GTR) to beneficially modify the properties of the pavement in highway construction. Determine the temperature-dependent rheological properties in an appropriate temperature range with a special DSR setup based on a concentric cylinder Peltier-controlled temperature device.

Determination of temperature-dependent rheological behavior of asphalt binders according to DIN EN 14770

In addition to the existing standard methods Anton Paar offers various Peltier-controlled temperature devices which cover a wide temperature range. Enhance measurement possibilities to determine the temperature rheological properties of asphalt binders which are essential for their use i.e. in road construction.

Advanced asphalt binder and bitumen testing:

DSR tests on solid bitumen and asphalt mortar samples

Characterize materials from the glassy to the molten state over a large temperature range and consequently determine the material’s transition temperatures and relaxations precisely. With a dynamic mechanical analysis (DMA) the temperature and mechanical behavior of solids is investigated with a variety of available fixtures such as solid circular (SCF), rectangular fixtures (SRF), or parallel-plate systems.

The RheoCompass Software: New Paths for Asphalt and Bitumen Testing

RheoCompass is a navigation tool that gives you the complete overview as well as the exact insights you require. Designed for intuitive use, the client–and-server-based RheoCompass enables application-oriented template filtering, customized test and analysis definitions, highly simplified data retrieval, a fully automatic and fast temperature calibration and verification routine, and much more.
The best measuring geometry for your needs

Depending on the test method a large selection of measuring systems – parallel plate, cone-plate, and concentric cylinder systems – are available.

Easy fitting of measuring systems

When changing between measuring systems, QuickConnect provides great ease-of-use. The quick-fitting coupling allows one-handed connection of the measuring systems and ensures fast, convenient system changes without a screwing mechanism.

A clear view of your sample

TruRay is a unique lighting concept only available for SmartPave 92 which gives you a clear view of the sample and measurement surface. This is especially useful for the correct and precise filling of the measuring gap.

25 years of experience in one motor

The air-bearing-supported synchronous EC motor deploys a frictionless synchronous movement of the rotor inside that enables the most sensitive and therefore most precise movements. Whether investigating solids or low-viscosity liquids your results are accurate across a wide viscosity range.
## Accessories for SmartPave 92 and SmartPave 102

### The most accurate temperature control

Temperature has the biggest influence on rheological investigations on asphalt binders and bitumen. For this reason, Anton Paar offers a wide range of Peltier temperature devices with excellent heating and cooling characteristics.

<table>
<thead>
<tr>
<th>Peltier temperature control for parallel-plate systems (P-PTD 200) and hood for up to 120 °C (H-PTD 120)</th>
<th>Peltier temperature control for parallel-plate systems (P-PTD 200) and hood for up to 200 °C (H-PTD 200)</th>
<th>Air-cooled Peltier temperature control for parallel-plate systems (P-PTD 200/AIR) and hood for up to 200 °C (H-PTD 200/AIR)</th>
<th>Peltier temperature control for concentric-cylinder systems (C-PTD 180/AIR)</th>
<th>Peltier-based convection-temperature-control system (CTD 180)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Truly Peltier-temperature-controlled hood (US Patent 6,571,610)</td>
<td>- Truly Peltier-temperature-controlled hood (US Patent 6,571,610)</td>
<td>- CoolPeltier™: Peltier temperature control with built-in air-counter-cooling option that requires no additional fluid circulator for counter-cooling</td>
<td>- Temperature range: 0 °C to 180 °C</td>
<td>- Temperature range: -20 °C to 180 °C</td>
</tr>
<tr>
<td>- Temperature range: -30 °C to 120 °C</td>
<td>- Temperature range: -40 °C to 200 °C</td>
<td>- Smallest temperature gradients &lt;0.1 °C according to AASHTO T315</td>
<td>- No vertical temperature gradients in the sample due to patented thermal transfer system (US Patent 6,240,770)</td>
<td>- Rectangular (SRF) and cylindrical solid torsion (SOF) fixture for Dynamic Mechanical Analysis (DMA)</td>
</tr>
<tr>
<td>- Smallest temperature gradients &lt;0.1 °C according to AASHTO T315</td>
<td>- Dry sample area; no water or gas flow around the sample</td>
<td>- Smallest temperature gradients &lt;0.1 °C according to AASHTO T315</td>
<td>- CoolPeltier™: Peltier temperature control with built-in air-counter-cooling option that requires no additional fluid circulator for counter-cooling</td>
<td>- Humidity option available</td>
</tr>
<tr>
<td>- Dry sample area; no water or gas flow around the sample</td>
<td>- Dry sample area; no water or gas flow around the sample</td>
<td>- Dry sample area; no water or gas flow around the sample</td>
<td>- Suitable for rheological standard applications according to AASHTO, ASTM, DIN EN, and FGSV, as well as for GTR-modified (ground tire rubber) asphalt binder with particle sizes up to 2 mm (mesh 10)</td>
<td>- Parallel-plate: PP04 / PP06 / PP25 (other diameters on request)</td>
</tr>
<tr>
<td>- Sliding rail for easy access and sample trimming</td>
<td>- Sliding rail for easy access and sample trimming</td>
<td>- Sliding rail for easy access and sample trimming</td>
<td>- Recommended for all standard applications on bitumen and asphalt binder according to AASHTO, ASTM, DIN EN, and FGSV</td>
<td>- Cone-plate: different diameters and angles on request</td>
</tr>
<tr>
<td>- Recommended for all standard applications on bitumen and asphalt binder according to AASHTO, ASTM, DIN EN, and FGSV</td>
<td>- Recommended for all standard applications on bitumen and asphalt binder in an extended temperature range</td>
<td>- Recommended for all standard applications on bitumen and asphalt binder according to AASHTO, ASTM, DIN EN, and FGSV</td>
<td>- Special concentric cylinders for GTR-modified (ground tire rubber) asphalt binder testing: CC10SP / CC17SP</td>
<td>- Concentric-cylinder: CC10 / CC17 / CC27 (other diameters on request)</td>
</tr>
</tbody>
</table>

### Measuring systems:

- **Parallel-plate:**
  - PP04 / PP06 / PP25 (other diameters on request)
- **Cone-plate:**
  - Different diameters and angles on request
- **Concentric-cylinder:**
  - CC10 / CC17 / CC27 (other diameters on request)
- **Special concentric cylinders for GTR-modified (ground tire rubber) asphalt binder testing:**
  - CC10SP / CC17SP
# Specifications

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Unit</th>
<th>SmartPave 92</th>
<th>SmartPave 102</th>
<th>MCR 502S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing</td>
<td>-</td>
<td>Air</td>
<td>Air</td>
<td>Air</td>
</tr>
<tr>
<td>EC motor (brushless DC) with high-resolution optical encoder</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rotation mode</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Oscillation mode</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Direct strain, amplitude controller</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Direct stress, amplitude controller</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Maximum torque</td>
<td>mNm</td>
<td>125</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Minimum torque, rotation</td>
<td>nNm</td>
<td>1 µNm</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>Minimum torque, oscillation</td>
<td>nNm</td>
<td>1 µNm</td>
<td>7.5</td>
<td>50</td>
</tr>
<tr>
<td>Angular deflection, set value</td>
<td>µrad</td>
<td>1 to ∞</td>
<td>0.5 to ∞</td>
<td>0.05 to ∞</td>
</tr>
<tr>
<td>Step rate, time constant</td>
<td>ms</td>
<td>100</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Step strain, time constant</td>
<td>ms</td>
<td>100</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Step time (rate, strain), 99 % of set value (all samples)</td>
<td>ms</td>
<td>100</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Minimum angular velocity 1)</td>
<td>rad/s</td>
<td>10⁻⁴</td>
<td>10⁻⁴</td>
<td>10⁻⁹</td>
</tr>
<tr>
<td>Maximum angular velocity</td>
<td>rad/s</td>
<td>157</td>
<td>314</td>
<td>220</td>
</tr>
<tr>
<td>Minimum angular frequency 2)</td>
<td>rad/s</td>
<td>10⁻⁴</td>
<td>10⁻⁴</td>
<td>10⁻⁴</td>
</tr>
<tr>
<td>Maximum angular frequency</td>
<td>rad/s</td>
<td>628</td>
<td>628</td>
<td>628</td>
</tr>
<tr>
<td>Minimum speed (CSS/CSR)</td>
<td>rpm</td>
<td>10⁻³</td>
<td>10⁻³</td>
<td>10⁻³</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>rpm</td>
<td>1500</td>
<td>3000</td>
<td>2100</td>
</tr>
<tr>
<td>Normal force range</td>
<td>N</td>
<td>-</td>
<td>0.01 to 50</td>
<td>0.01 to 70</td>
</tr>
<tr>
<td>Normal force resolution</td>
<td>mN</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dimensions</td>
<td>mm</td>
<td>380 x 660 x 530</td>
<td>678 x 444 x 586</td>
<td>753 x 444 x 586</td>
</tr>
<tr>
<td>Weight</td>
<td>kg</td>
<td>33</td>
<td>42</td>
<td>47</td>
</tr>
<tr>
<td>Toolmaster™, measuring system</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Toolmaster™, measuring cell</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>QuickConnect for measuring systems, screwless</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Electronic trim lock for the measuring system</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Virtually gradient-free (horizontal, vertical) temperature control</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Temperature gradient &lt; 0.1 °C according to AASHTO and ASTM</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Maximum temperature range 4)</td>
<td>°C</td>
<td>-40 to 400</td>
<td>-180 to 1000</td>
<td>-180 to 1000</td>
</tr>
<tr>
<td>DoorPeltier™, Peltier system with built-in cooling option that does not require additional accessories for counter-cooling</td>
<td>-</td>
<td>-5 to 200</td>
<td>-5 to 200</td>
<td>-5 to 200</td>
</tr>
<tr>
<td>Actively Peltier-controlled hood, Peltier technology</td>
<td>-</td>
<td>-5 to 200</td>
<td>-5 to 200</td>
<td>-5 to 200</td>
</tr>
<tr>
<td>Concentric-cylinder Peltier temperature control</td>
<td>-</td>
<td>5 to 150</td>
<td>5 to 150</td>
<td>5 to 150</td>
</tr>
<tr>
<td>Peltier-based convection oven, does not require LN₂ for cooling</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Pressure Cell</td>
<td>bar</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Automatic gap control/setting (AGC/AGS)</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>TruGap™ for in-place measurement and control of the gap</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>SafeGap™, normal force limiter during gap setting</td>
<td>-</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>TruRay™, dimmable illumination of sample area</td>
<td>-</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>TPReady™</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

### Specifications

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Unit</th>
<th>SmartPave 92</th>
<th>SmartPave 102</th>
<th>MCR 502S</th>
</tr>
</thead>
<tbody>
<tr>
<td>TruRate™</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>TruStrain™</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Advanced Lift Drive Control (velocity profiles, load, squashes)</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Normal force (normal force read/control)</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Raw data (LAOS, waveform, ...)</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

### Specifications

<table>
<thead>
<tr>
<th>Specifications</th>
<th>SmartPave 92</th>
<th>SmartPave 102</th>
<th>MCR 502S</th>
</tr>
</thead>
<tbody>
<tr>
<td>RheoCompass software</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Asphalt standard operation procedures (SOP)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Fully automatic temperature calibration</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Test Designer</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Report Designer</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Managed lab, multiple clients and server</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

### Applications

- AASHTO T315 / ASTM D7175 (SHRP-Test/Superpave PG)
- AASHTO T316 / ASTM D4402 / DIN EN 13302 & 13702 (Rotational Viscosity)
- AASHTO T350 / ASTM D7405 / DIN EN 16659 / FGSV AL 723 (MSCR-Test)
- DIN EN 14770
- AASHTO TP101-UL (LAB-Test)
- AASHTO TP123 BYET
- FGSV AL 720 / 721 / 722 / 723
- Master curves 1)
- GTR-modified (ground tire rubber) asphalt binders (AASHTO draft)
- Low-temperature measurements -30 °C / Parallel plates 4 mm (AASHTO draft)
- Low-temperature measurements -20 °C / Torsion
- Fatigue crack measurements in torsion (high max. torque required)
- Tribological measurements with pin-on-disk (T-PD/44)

### Legend

- ✓ included
- X not available
- ○ optional

1) Dependent on measuring point duration and sampling time practically any value can be achieved
2) Set frequencies below 10⁻⁴ rad/s are of no practical relevance due to the measuring point duration > 1 day
3) Theoretical value (duration per cycle = 2 years)
4) Depending on temperature device used
5) System temperature, sample temperature may vary. For measurements at very high or low temperatures a calibration in the sample gap is recommended.
6) Analysis package required

**SmartPave (016731556) and RheoCompass (0177015) are registered trademarks of Anton Paar.**