

The image shows a close-up of the Anton Paar MCR 703 MultiDrive rheometer. The central component is a vertical probe assembly. The upper part is a black, cylindrical motor housing. Below it is a silver-colored shaft with a black grip section. The shaft is labeled with 'SCF 7' and '30404'. The lower part of the shaft is a black, cylindrical sensor head. The entire assembly is mounted on a circular, metallic base plate. The background is a light blue gradient.

# Previously Unthinkable Material Characterization

MCR 703 MultiDrive

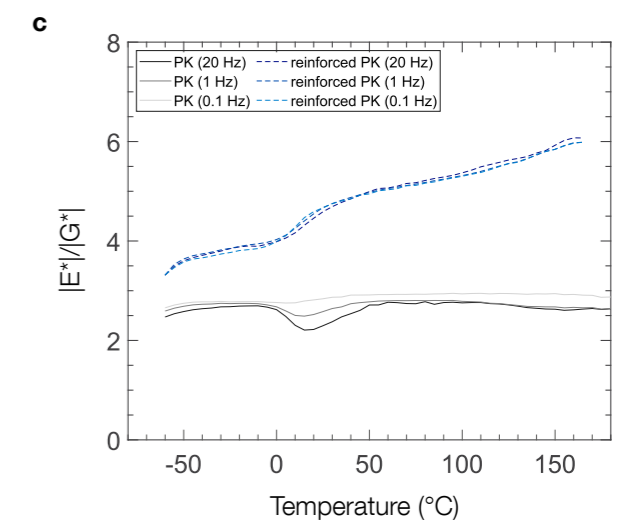
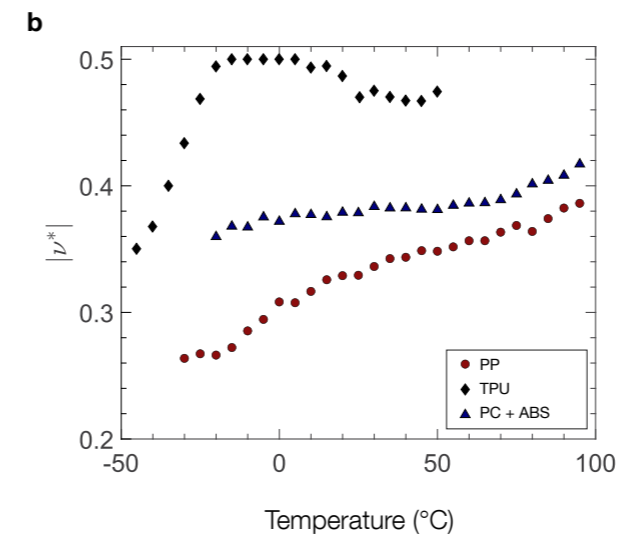
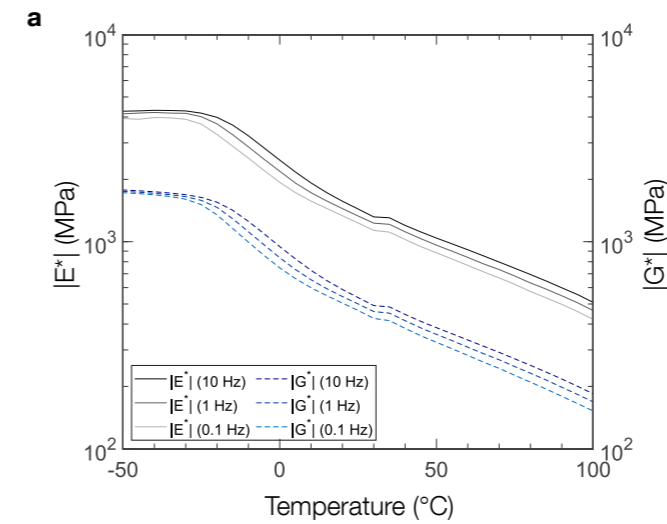
# Axial-Torsional Dynamic Mechanical Analyzer



The concept of using a state-of-the-art moving-magnet motor and renowned EC motor technology enables you to perform even dynamic mechanical analysis in tension and torsion within one test definition and without changing the specimen.

This allows the precise determination of the complex Young's modulus ( $E^*$ ) and the complex shear modulus ( $G^*$ ) as a function of temperature, frequency, time, or humidity within a single experiment.

In this way, MCR 703 MultiDrive opens up a completely new field of material characterization based on dynamic mechanical analysis. For the first time, the Poisson's ratio of isotropic materials can be determined accurately and quickly using a single sample. In addition, when investigating anisotropic materials such as composites, fast direction-dependent characterization is possible, which enables a more comprehensive analysis of the sample properties.



## Poisson's ratio of isotropic materials

With axial-torsional DMA, both  $E^*$  and  $G^*$  can be obtained from a single sample in a single measurement and under the same experimental conditions (see Graph a for a polypropylene sample). This approach allows the complex Poisson's ratio,  $\nu^*$ , to be indirectly determined as a function of temperature and frequency for isotropic samples.

Graph b shows the complex Poisson's ratio versus temperature for three standard polymers: thermoplastic polyurethane (TPU), a polycarbonate (PC)/acrylonitrile-butadiene-styrene (ABS) blend, and semi-crystalline polypropylene (PP). Knowing the exact Poisson's ratio helps optimize material design and analysis, and improves predictions of strength, stability, and potential failure.

## Testing of anisotropic materials

For anisotropic samples, axial-torsional DMA provides further insight into the viscoelastic anisotropy as a function of frequency and temperature. Graph c compares simultaneous measurements of  $E^*$  and  $G^*$  for a polyketone (PK) and for the same material reinforced with carbon fibers. The unreinforced material shows a temperature-dependent change in  $E^*/G^*$ , shifting to values between 2 and 3, which is typical for isotropic materials.

On the other hand, the reinforced variant shows that the resistance to extension ( $E^*$ ) remains between three and six times that of the resistance to torsion ( $G^*$ ), with a trend that is highly temperature-dependent. This indicates strong dependence of material properties on load direction for anisotropic materials.



