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REPORT

Rheological properties of Cyber Clean® as a function of the temperature

Ihr Zeichen/ Your Code:
Ihre Nachricht vom/ Your letter Date:

Mein Zeichen/ My Code:
Datum/ Date: 2010-03-29

Report Number:	**100329-03 – Part 1**
Customer:	Joker AG/SA Industriezone 27 CH-3210 Kerzers
Test item:	Cyber Clean®
Contract date:	2009-08-31
Sample arrival date:	2010-03-29
Test period:	20010-05-06 to 2010-03-29

Bank account:
Stadtsparkasse Mönchengladbach
Kto.Nr.: 333 5924
BLZ: 310 500 00
IBAN: DE44 310 500 00 0003335924
SWIFT: MGLSDE33

Geschäftsführer:
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Dipl.-Kfm. Norbert Krämer
Amtsgericht Mönchengladbach HRB 12304
USt-Id Nr.: DE 255 934 812
Steuer-Nr.: 121/5718/0930

1. Test item

By the material data sheet of the Joker AG/SA Cyber Clean® is described as an ethanol containing cleaning gel.

2. Task

The properties of Cyber Clean® regarding typical rheological parameters shall be investigated depending on heating treatment and cooling down.

3. Methods

The investigations were ruled out by Aachen engineering of RWTH, chair of mechanical engineering, in collaboration with EPA - Elektro-Physik-Aachen.

The rheological properties of Cyber Clean® were investigated by oscillation tests with the Searle Rheometer. The parameters loss angle [°] and modulus of rigidity [Pa] were measured.

The measurements were performed as a function of temperature in the range of -15°C to 50°C. Measurements below -15°C were not possible because of the stiffness of the test material at very low temperatures.

4. Terms and definitions

4.1. Loss angle

The parameter loss angle (δ) describes basically the ratio of the accumulated energy and the energy loss during the deformation of the material.

An ideal solid has got a loss angle δ= 0°, an ideal liquid has got a loss angle δ=π/2 or δ=90°. In real solids the loss angle ranges between δ= 0° and δ=90°. The closer the loss angle is to δ=0°, the more solidly is the material and the nearer the loss angle is to δ=90° the more fluidly is the material.

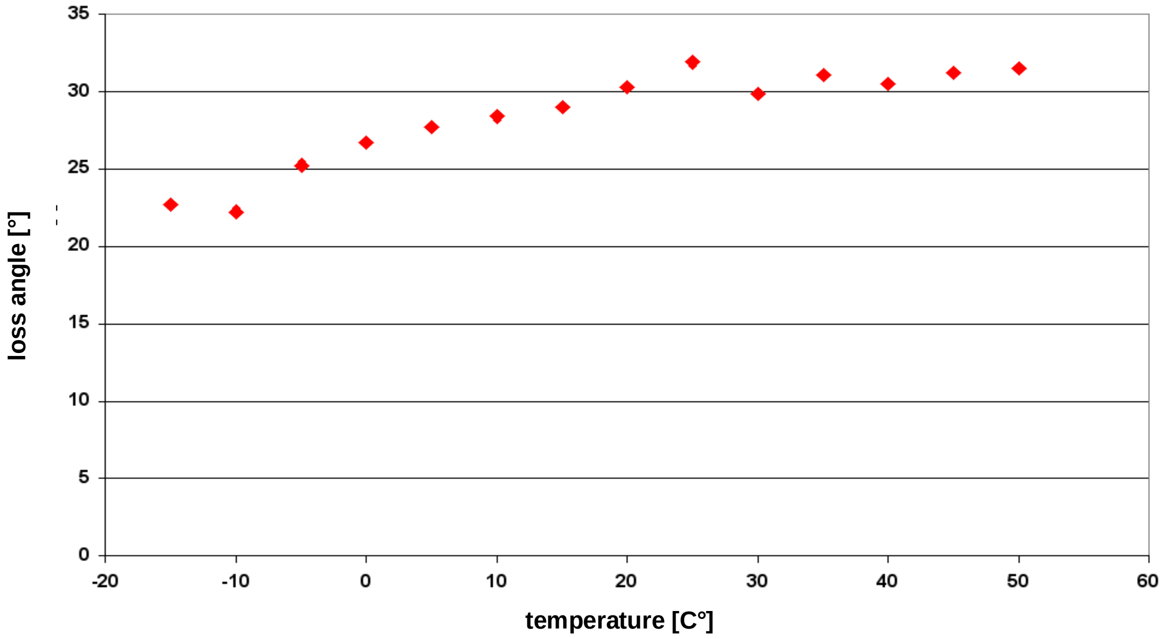
4.2. Modulus of rigidity

The modulus of rigidity measures the total amount of energy required for the deformation of the material.

Associated with the modulus of rigidity, two more parameters are important: the storage module and the loss module. The storage module stands for the energy accumulated during the deformation process, the loss module stands for the energy loss due to friction.

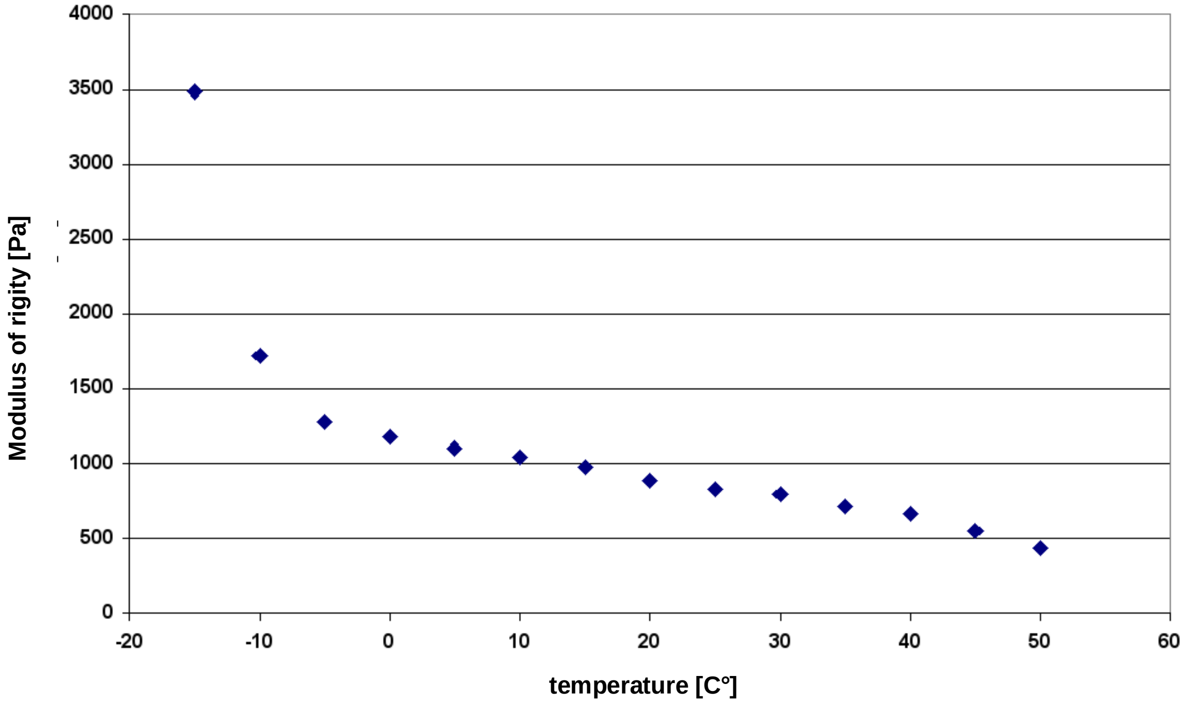
The ratio of accumulated energy to energy loss is indicated by the loss angle.

5. Results



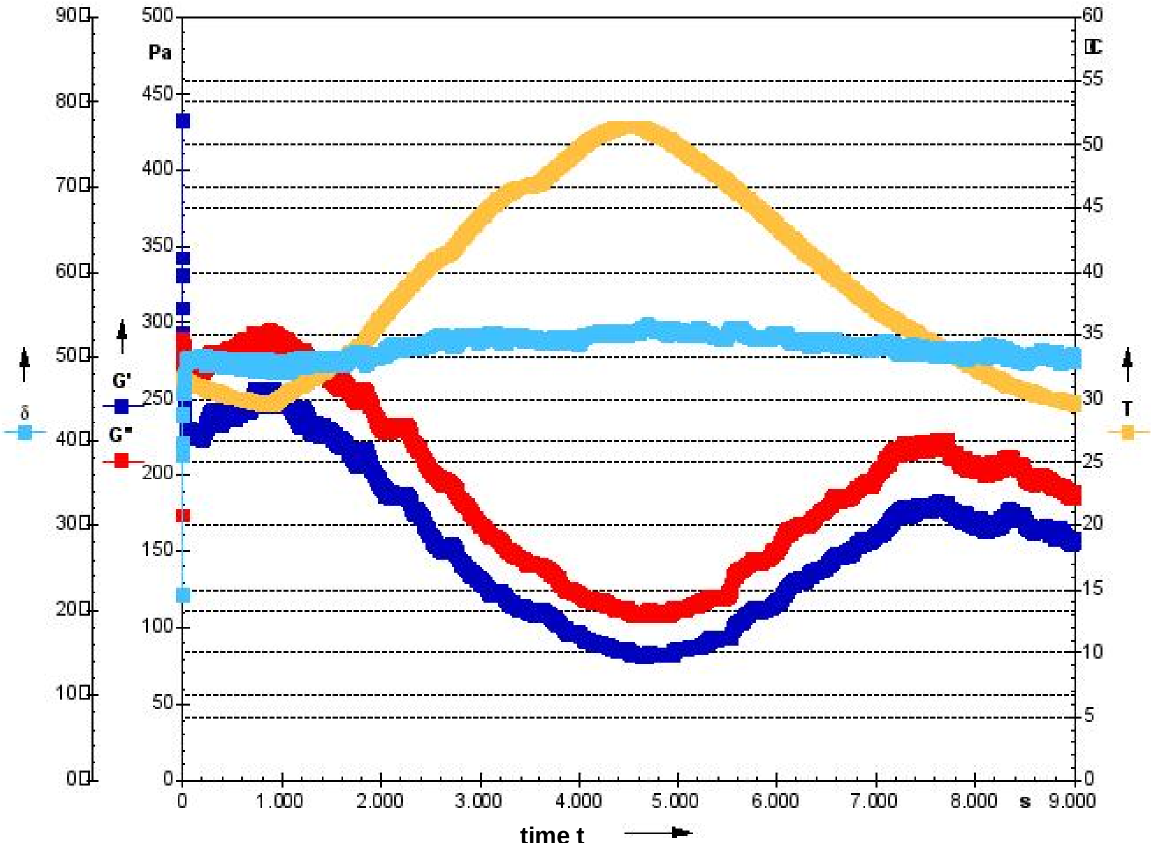
Pic. 1: Loss angle in the temperature range of -15 °C to +50 °C

At 23 °C, the loss angle indicates that the material resembles more a solid than a liquid. Between 15°C und 50°C the consistence of the material as measured by the loss angle is more or less constant. At negative temperatures the consistence of the material changes.



Pic. 2: Modulus of rigidity in the temperature range of -15 °C to +50 °C

At negative temperatures, the modulus of rigidity is highest. As the modulus of rigidity represents the resistance versus the deformation process, it can be stated that the deformation resistance is highest at low temperatures. At higher temperatures, this resistance reduces significantly. This indicates that at higher temperatures the deformation is easier.



Oszillation phi = 20° f = 0,25 Hz: each 900 s in 5°C steps from 30°C up to50°C and back to 30°C

G' storage module

G" loss module

T temperature

δ loss angle

Pic. 3: Rheological parameters as a function of the temperature, measured in a temperature cycle of 30°C to 50°C to 30 °C.

6. Summarizing assessment

Summarized, the material shows mainly elastic properties. With decreasing temperature, the more the material resembles a solid and the stiffness increases.

During the heating treatment up to 50°C and the following cooling down to room temperature, the loss angle of Cyber Clean® remains almost stationary.

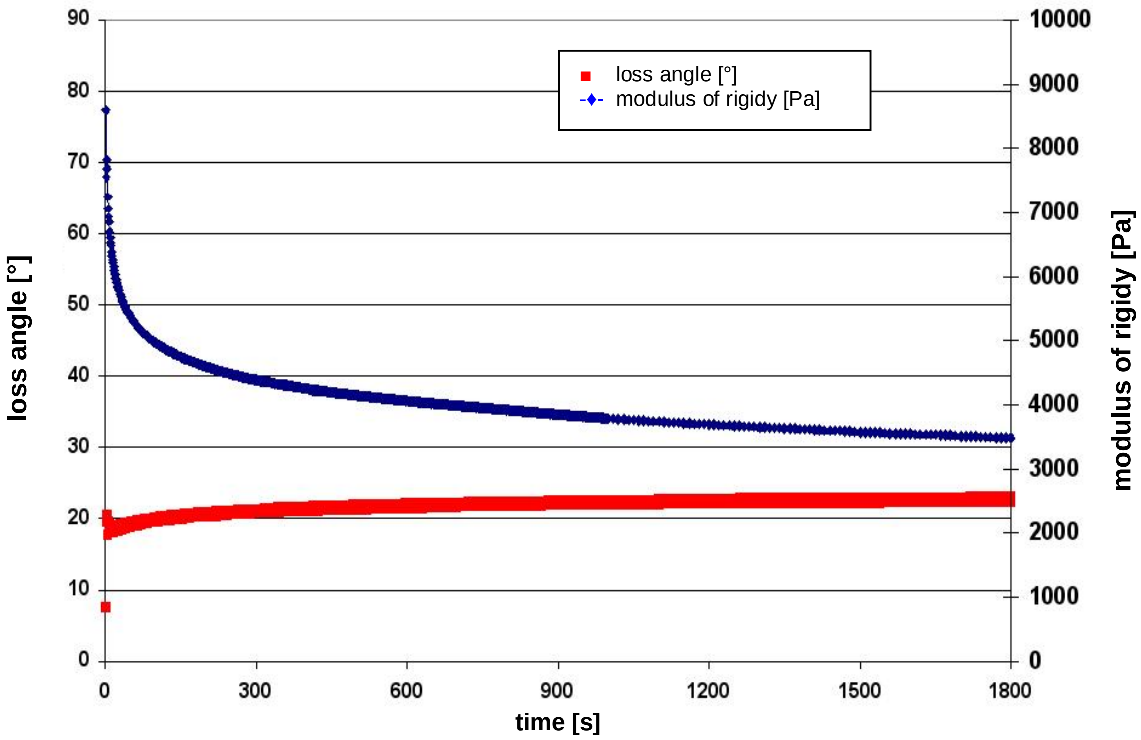
But the loss module and the storage module each decrease during the heat treatment, the material can be deformed more easily. After the cooling down to room temperature, the starting level for both parameters could not regained. This indicates a permanent change of the material properties. An explanation could be the loss of ethanol during the heat treatment.

Mönchengladbach, 14th of may 2010
GUI- Gesellschaft für Umwelt- und Innenraumanalytik

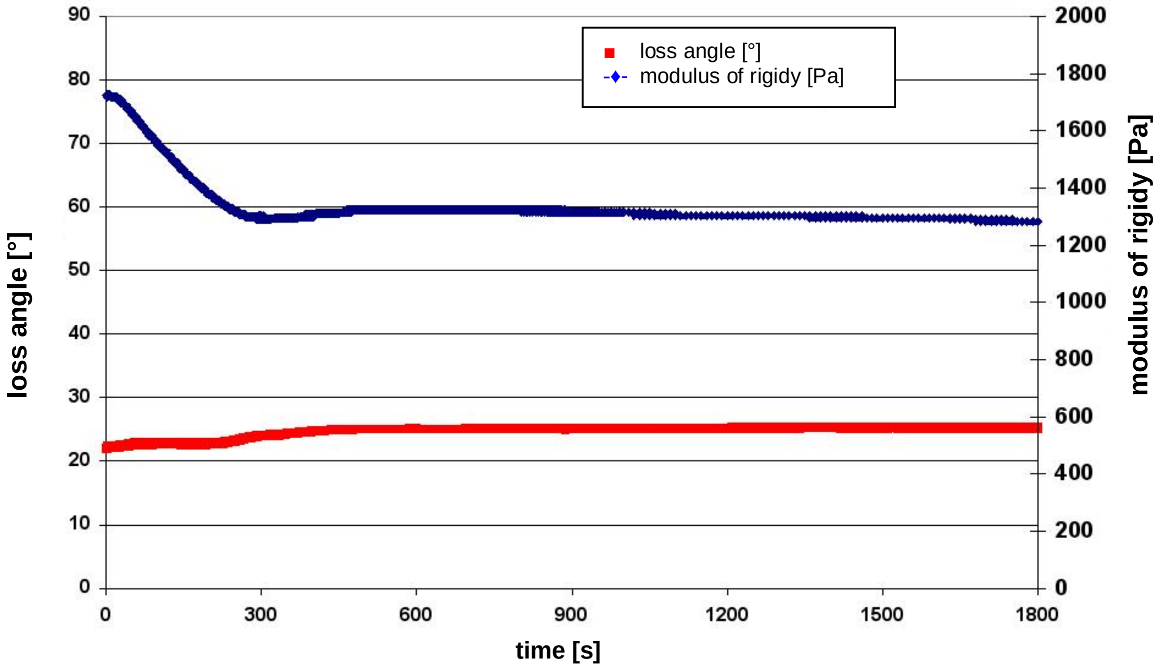
(Dr. Andreas Winkens VDI) - managing director -	(Dipl.- Ing. Frank Praetorius VDI) - technical director -

Annex

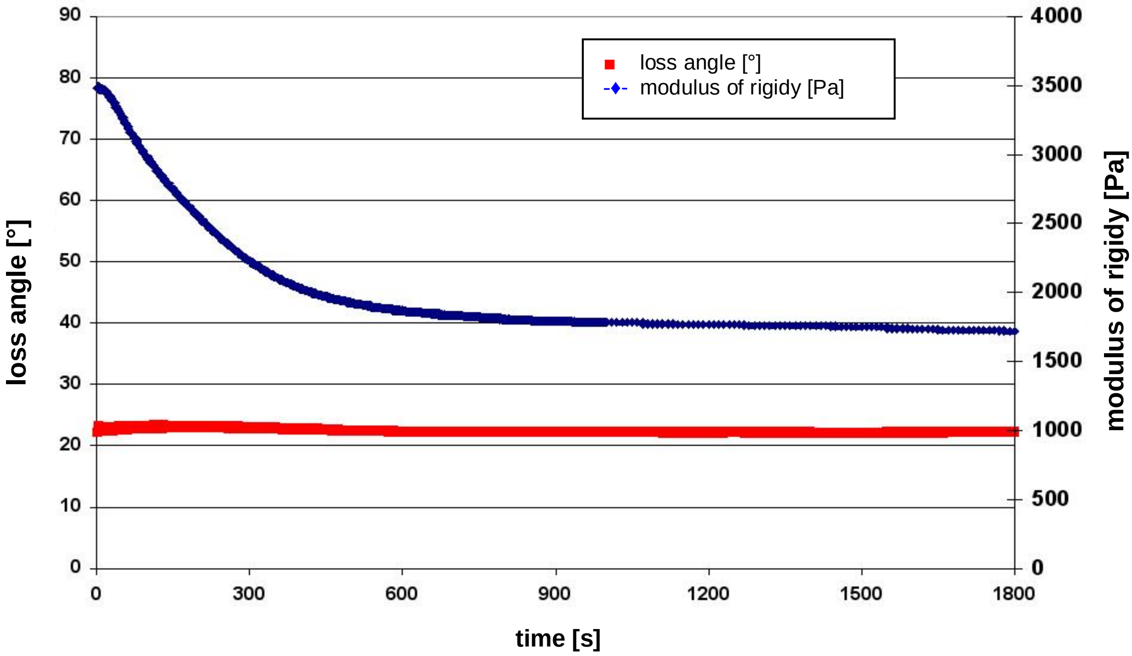
of Report No. 100329-03 part 1



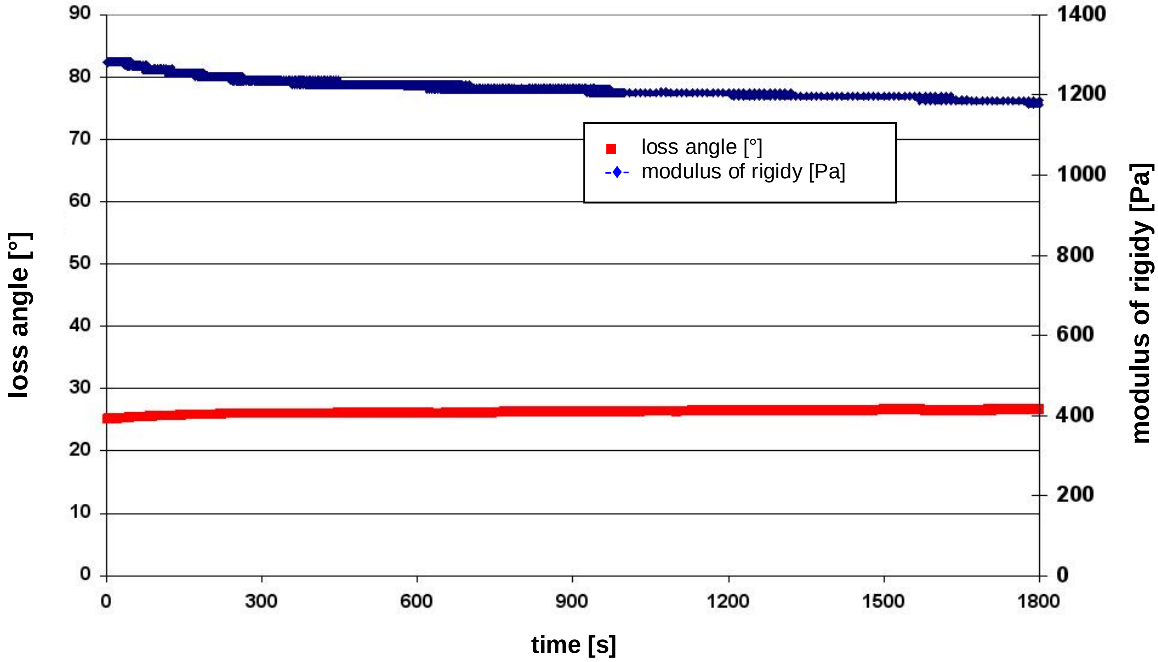
Pic. 4: Loss angle and modulus of rigidity at -15 °C



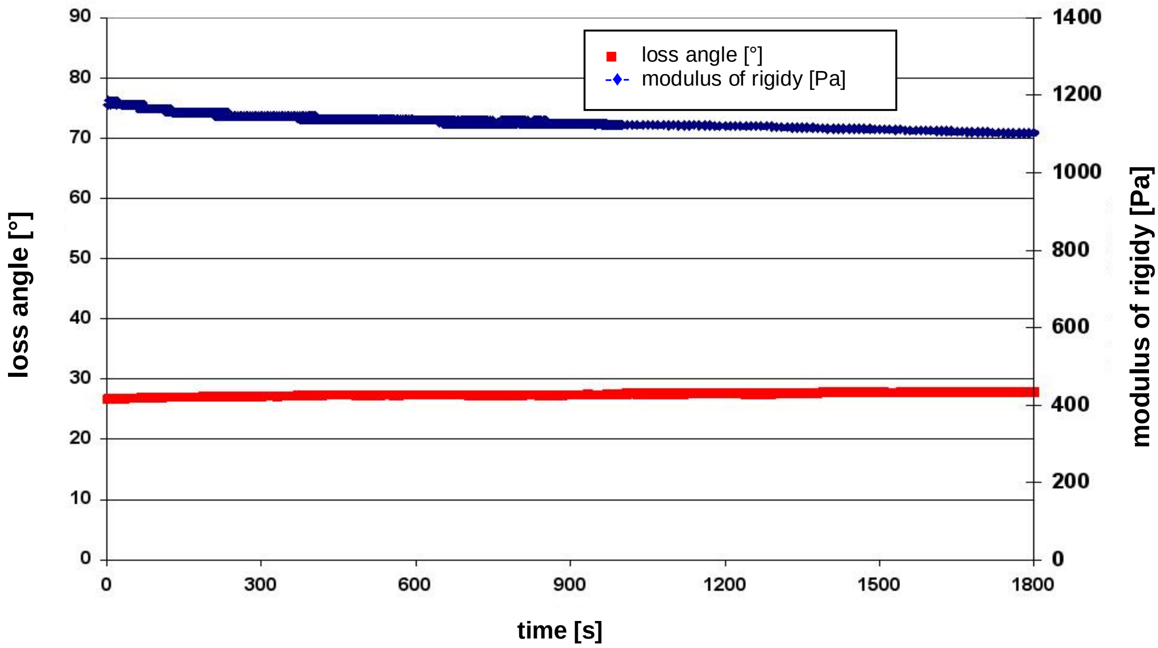
Pic. 5: Loss angle and modulus of rigidity at -10 °C



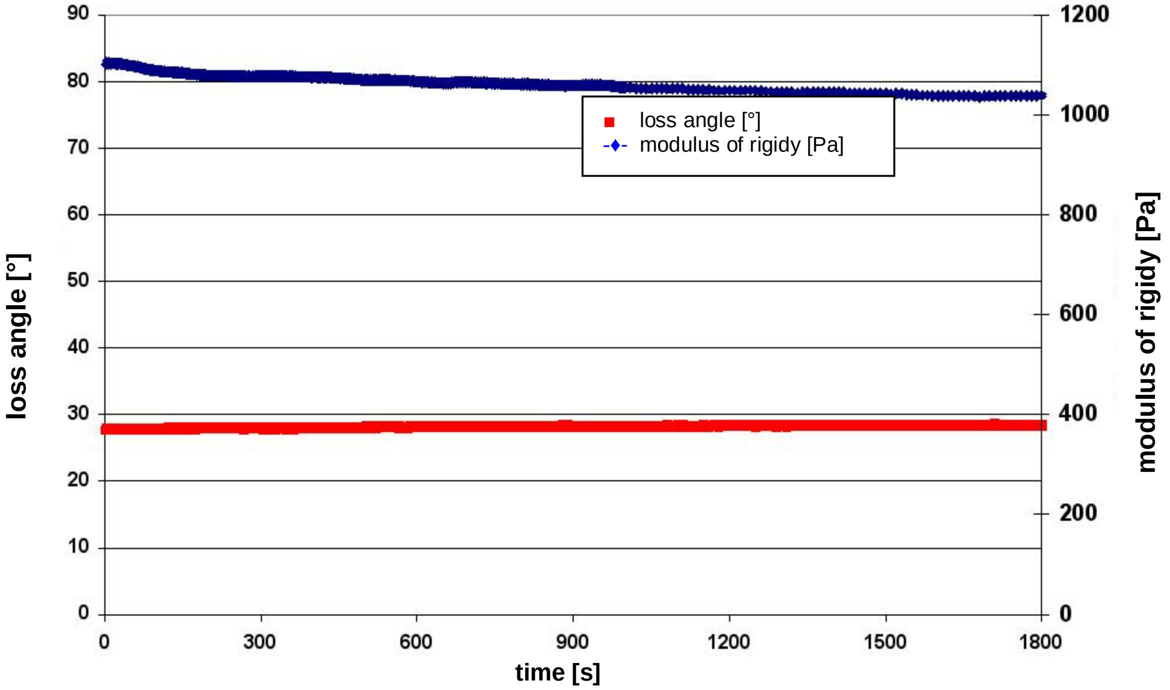
Pic. 6: Loss angle and modulus of rigidity at -5 °C



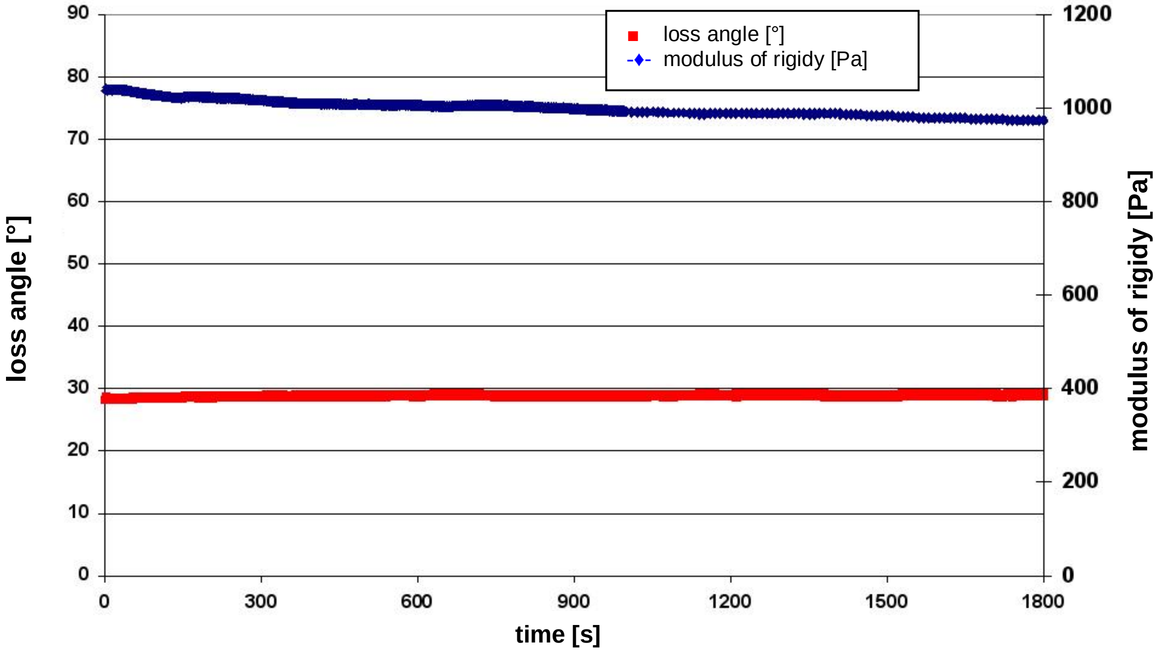
Pic. 7: Loss angle and modulus of rigidity at 0 °C



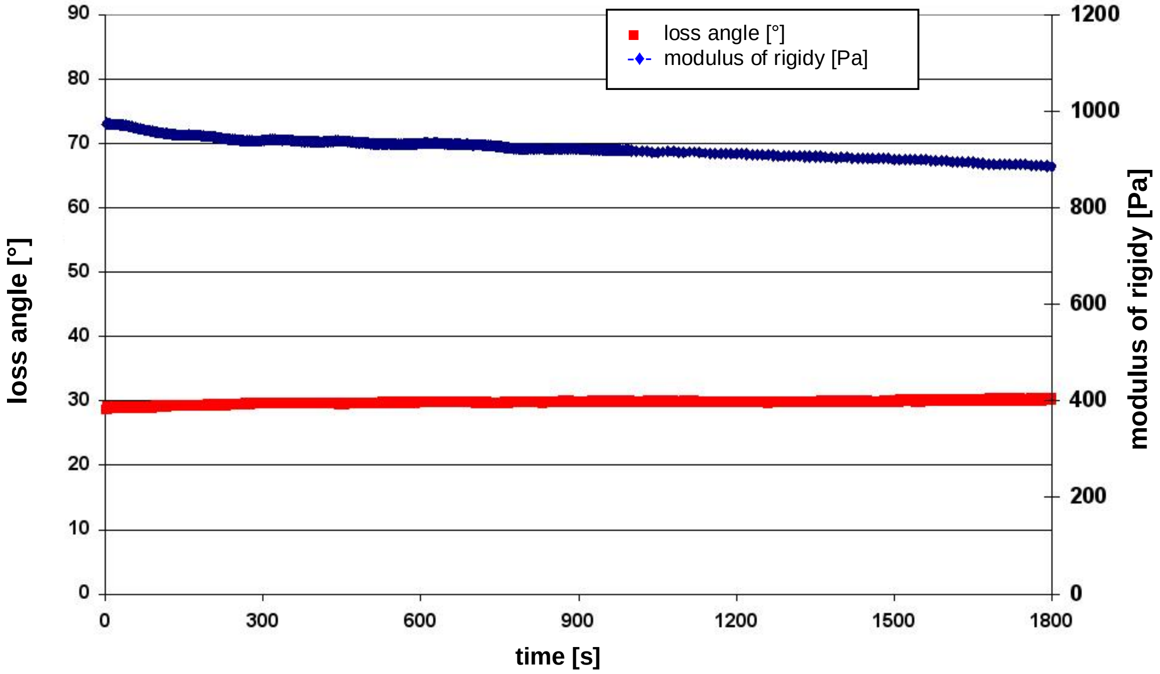
Pic. 8: Loss angle and modulus of rigidity at +5° C



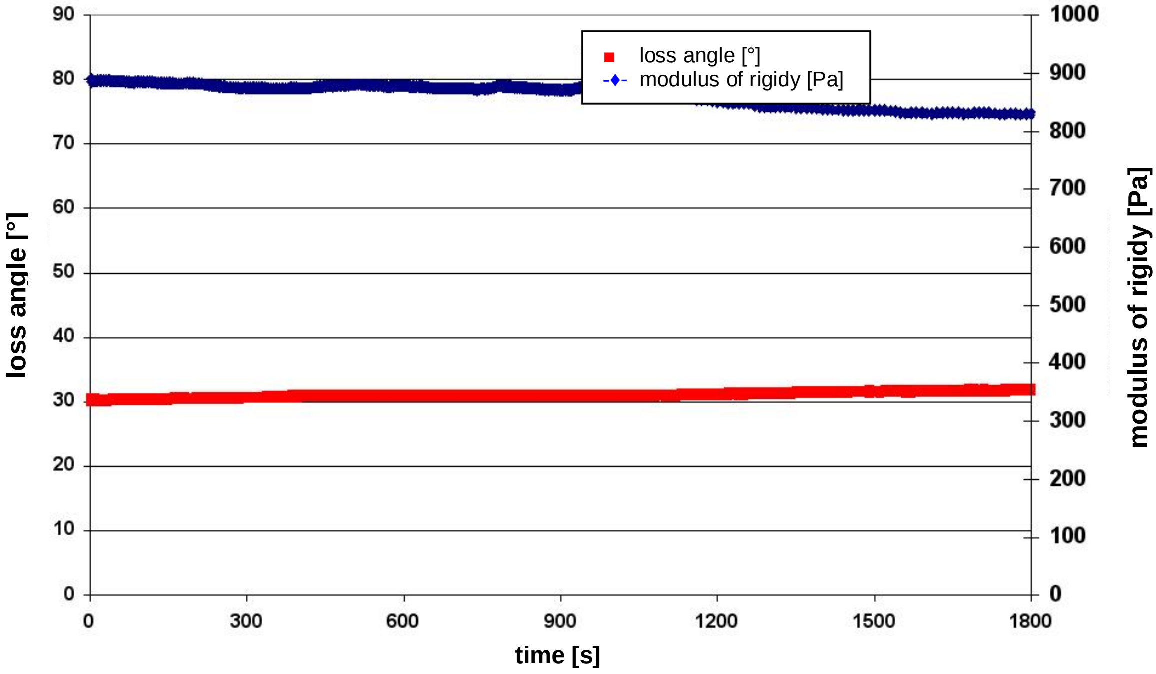
Pic. 9: Loss angle and modulus of rigidity at +10 °C



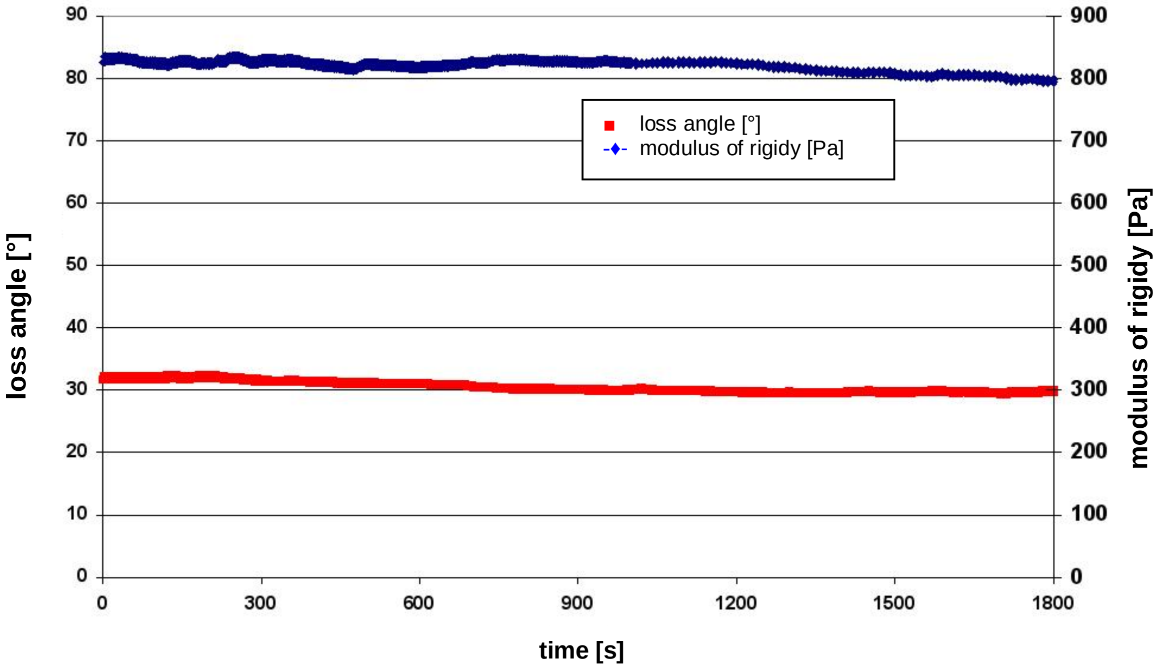
Pic. 10: Loss angle and modulus of rigidity at +15 °C



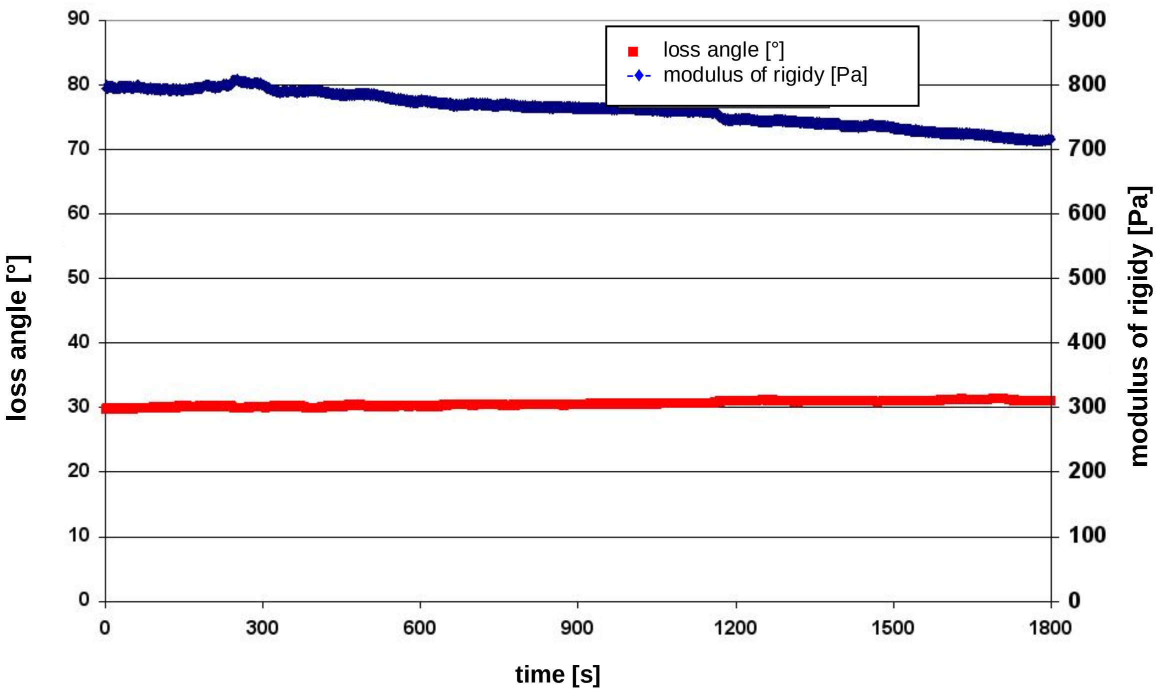
Pic. 11: Loss angle and modulus of rigidity at +20 °C



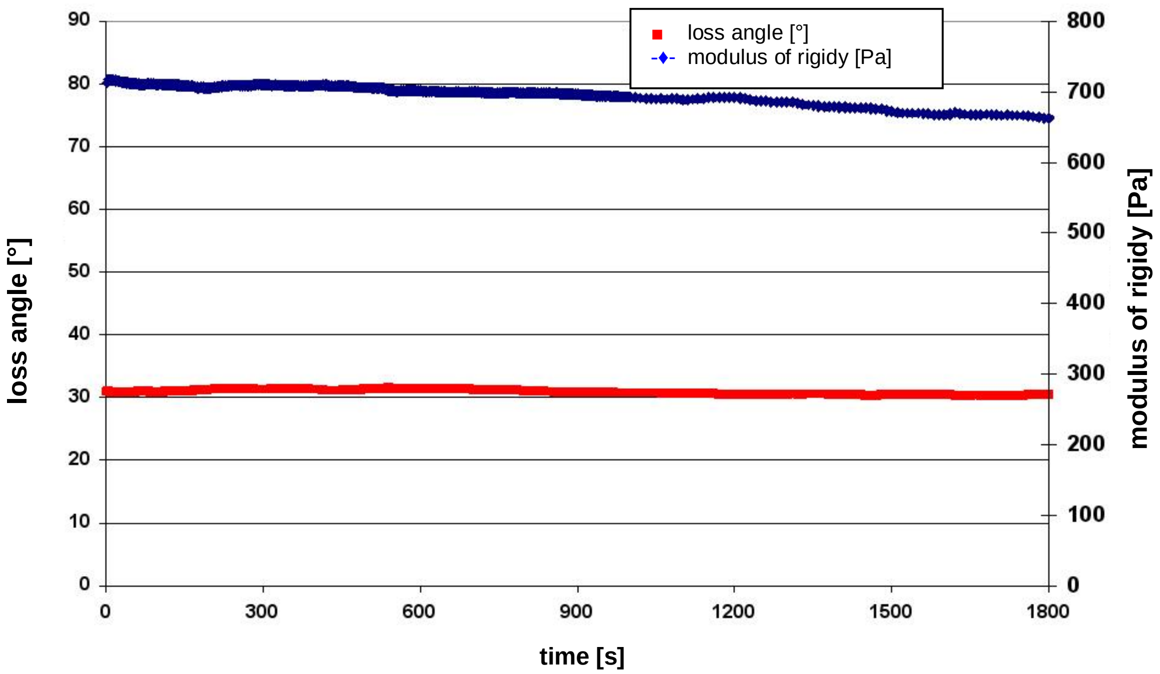
Pic. 12: Loss angle and modulus of rigidity at +25 °C



Pic. 13: Loss angle and modulus of rigidity at +30 °C

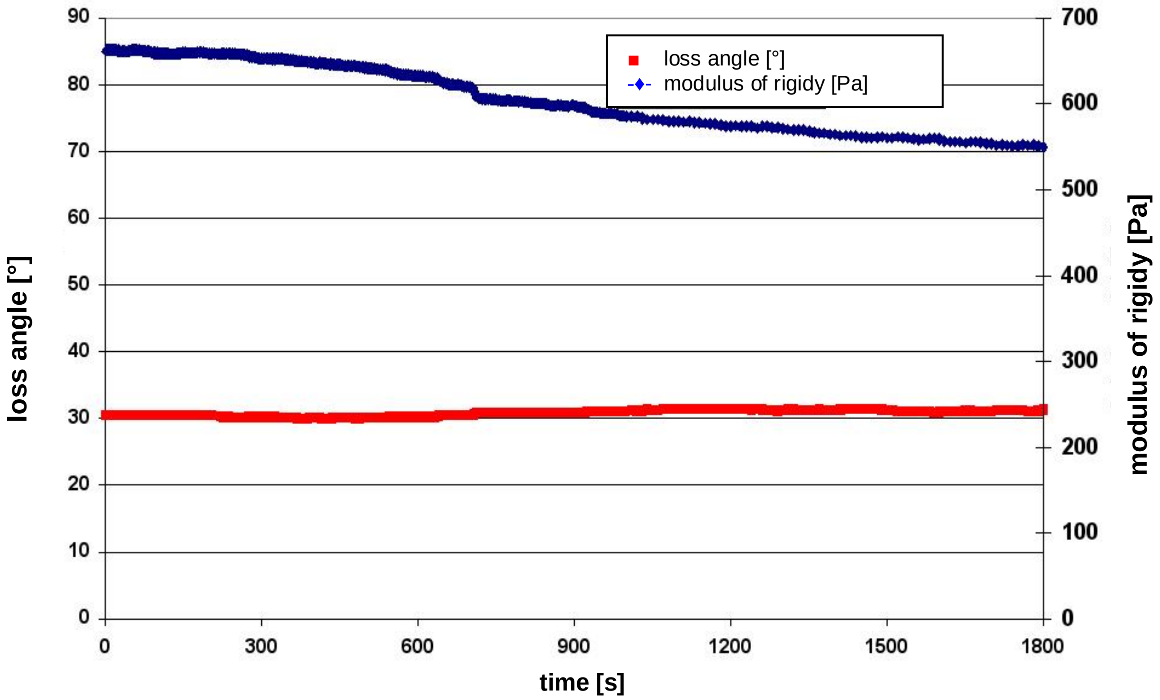


Pic. 14: Loss angle and modulus of rigidity at +35 °C

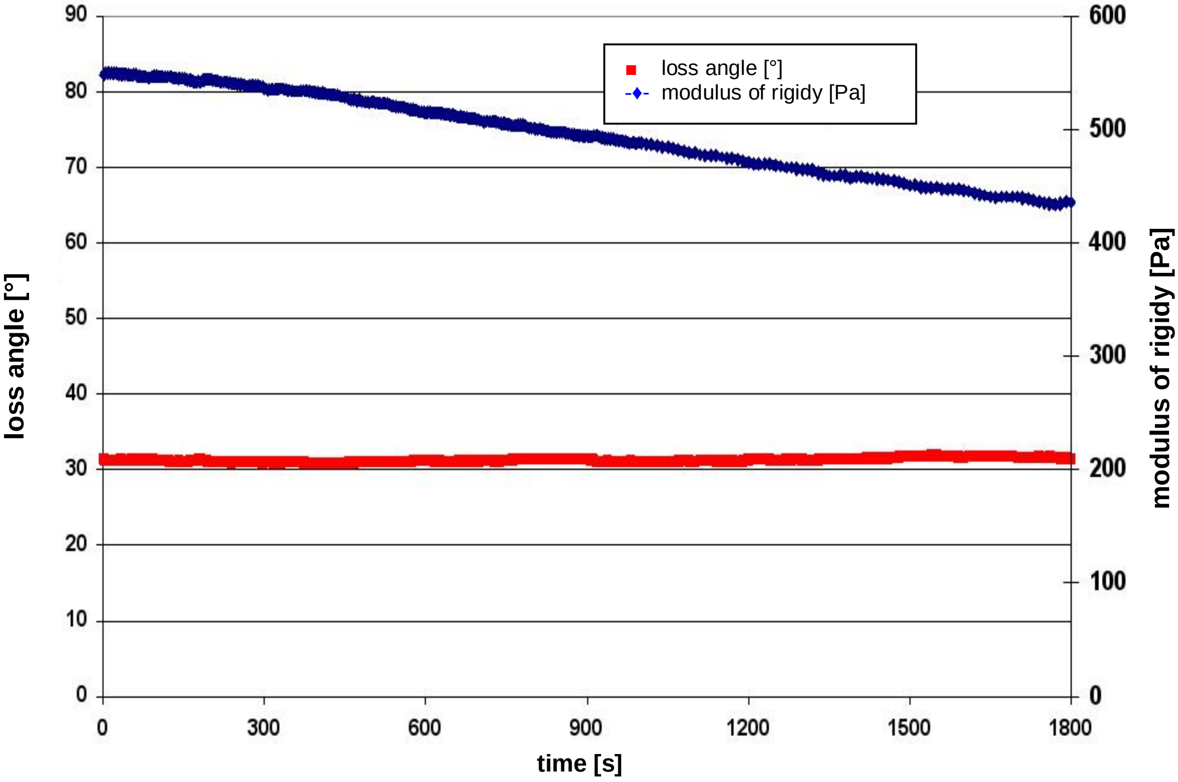


Pic.

15: Loss angle and modulus of rigidity at +40 °C



Pic. 16: Loss angle and modulus of rigidity at +45 °C



Pic. 17: Loss angle and modulus of rigidity at +50 °C