



Advanced Solder Materials for High-Temperature Application HISOLD
Expression of Interest for COST MP0602

Measurement of atomic structure and physical properties of Pb-free solders for high-temperature applications

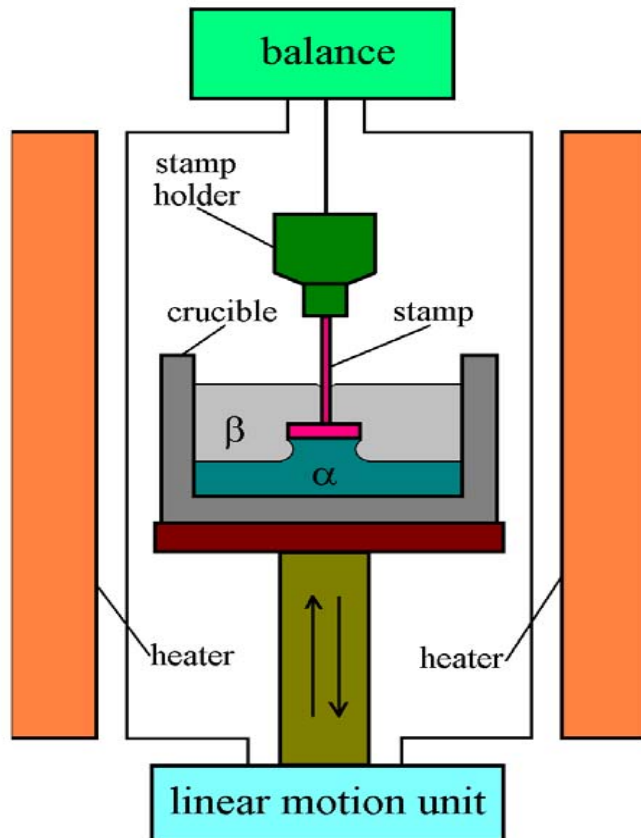
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<http://www.tu-chemnitz.de/physik/RND>

Measurement of Surface Tension and Density

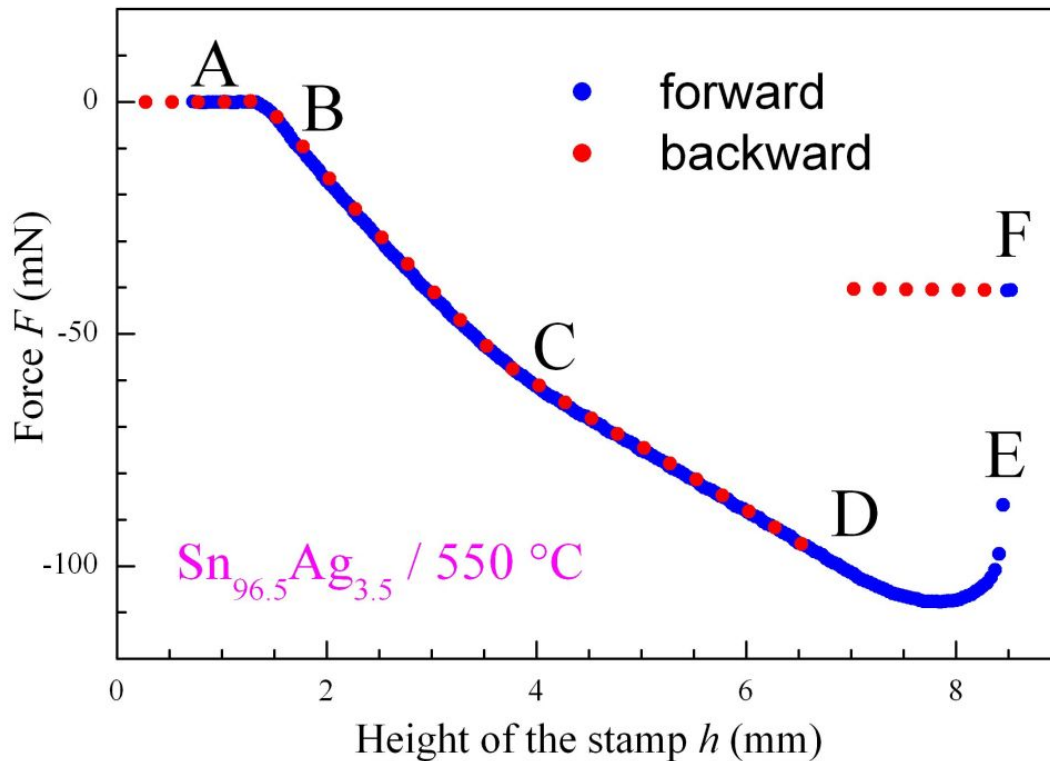
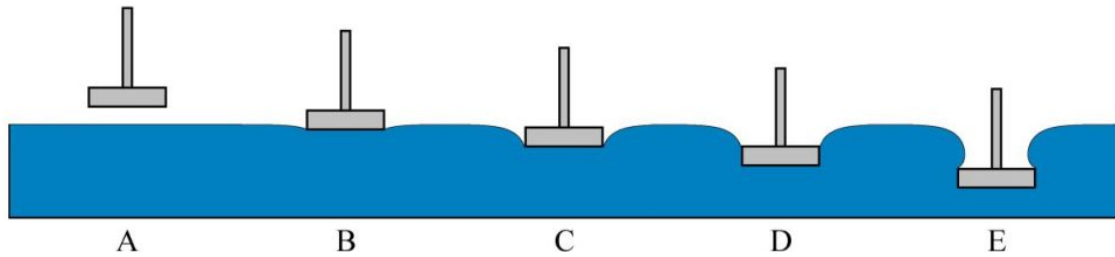


Temperature – up to 1100°C

Inert gas – Ar, Ar-10%H₂

Scheme of the tensiometer

Tensiometric measurement

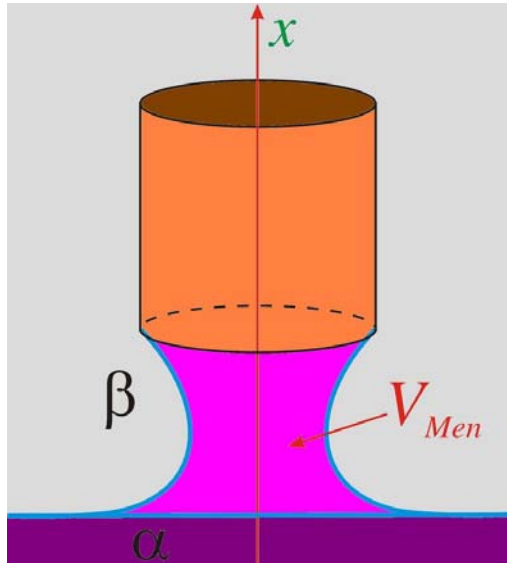


Density

$$\rho = \frac{dF_{CD}^{\text{exp}}}{dh} \frac{1}{g\pi} \left(\frac{1}{r_s^2} - \frac{1}{R_t^2} \right)$$

Experimental curve for liquid
 $\text{Sn}_{96.5}\text{Ag}_{3.5}$

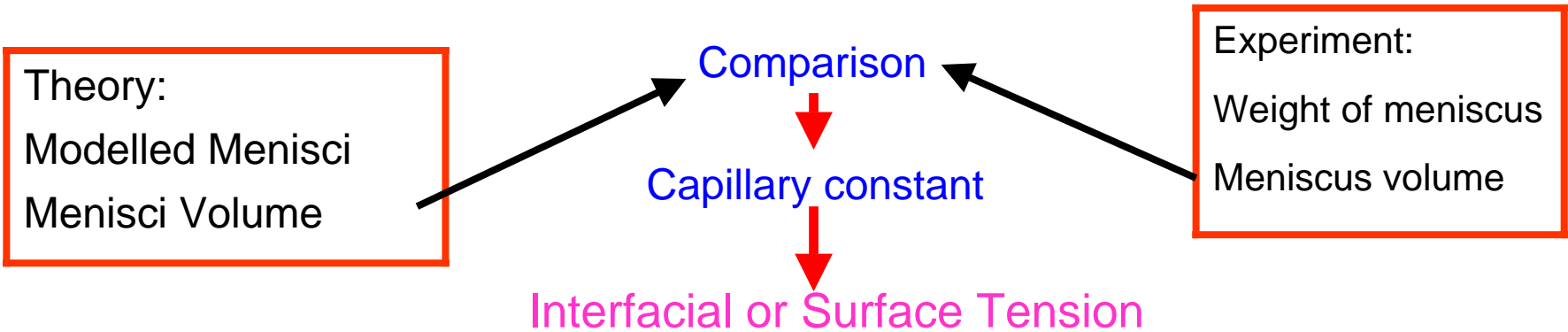
Experiment: meniscus volume



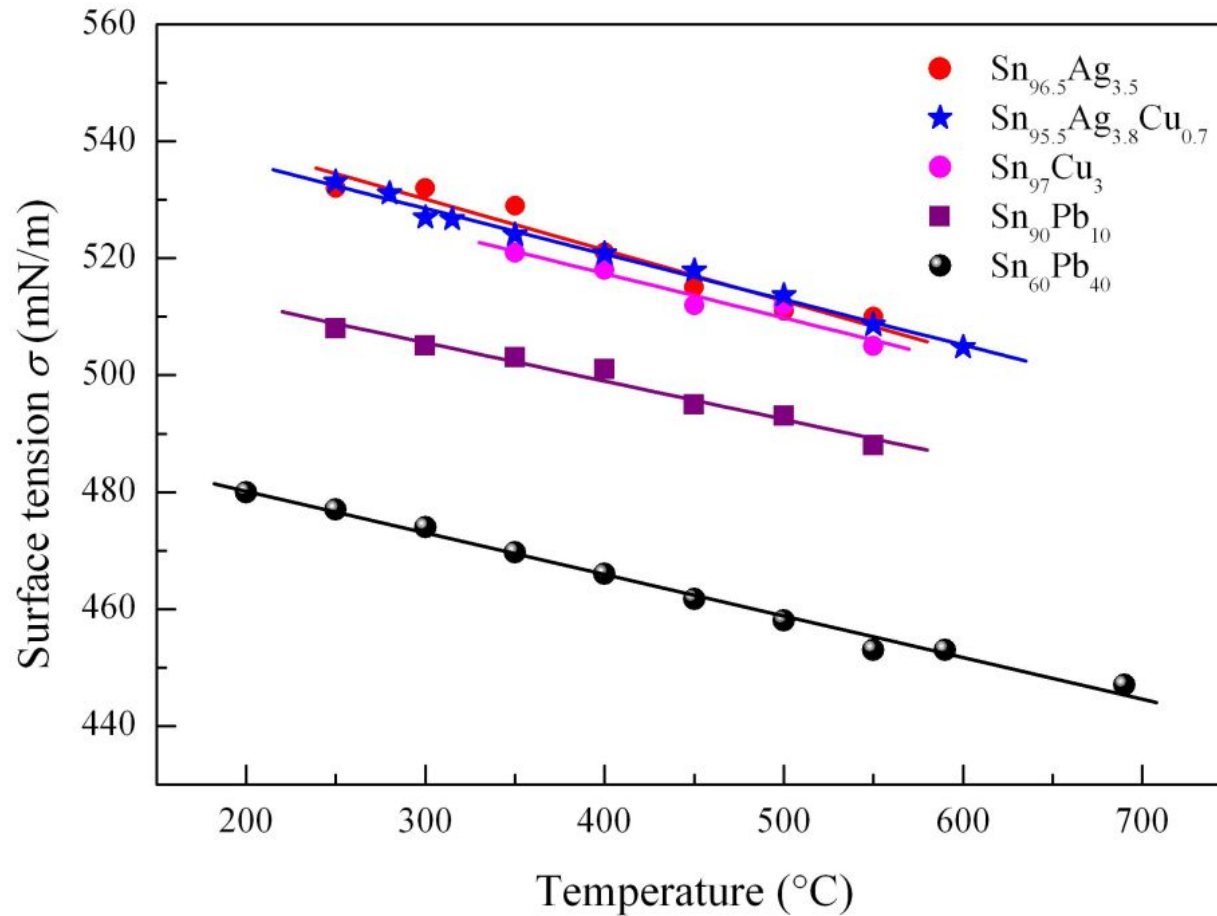
Weight of meniscus is proportional to its volume:

$$F_{\text{Men}} = \Delta\rho g V_{\text{Men}}$$

Measured force \rightarrow Meniscus Volume
 (after correction for buoyancy and geometry)



Sn-based solders: surface tension

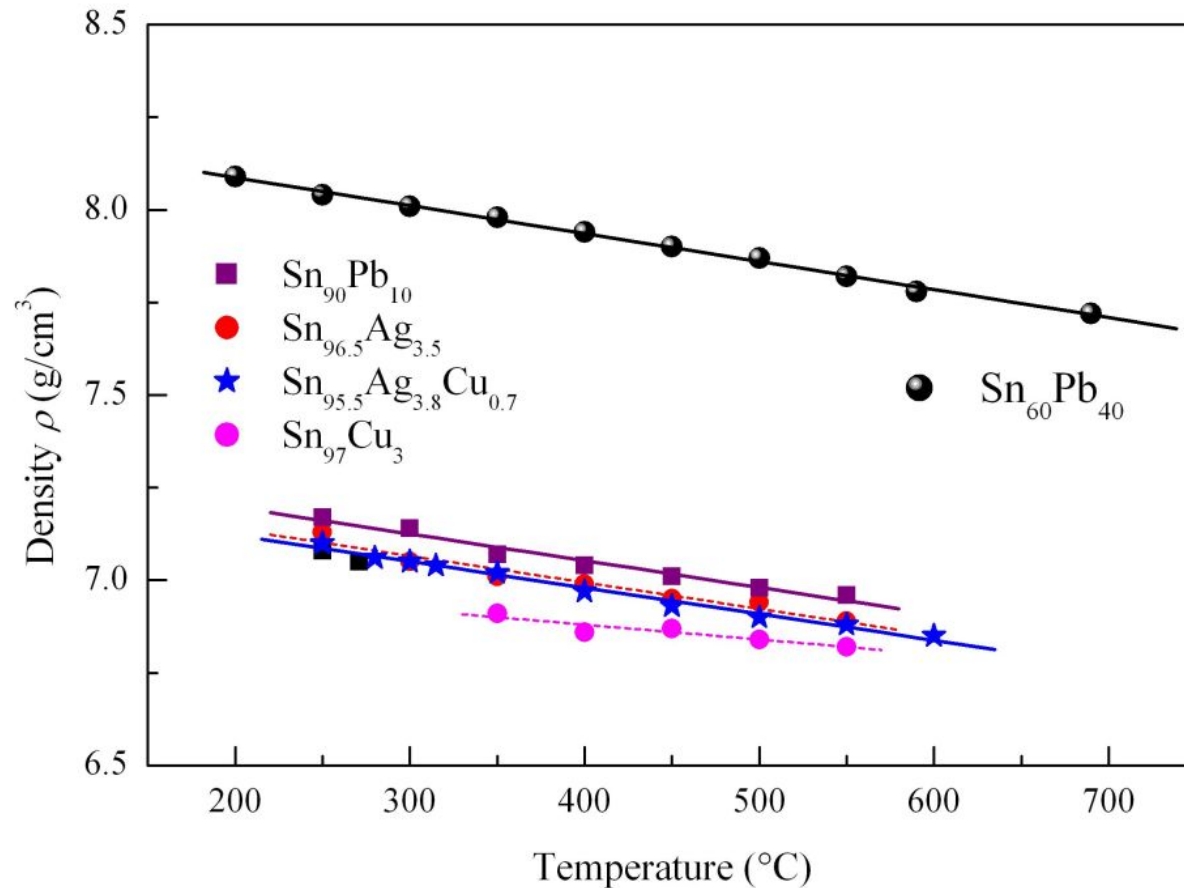


accuracy: $\pm 5\%$

Kaban I., Mhiaoui S., Hoyer W., Gasser J.-G. J. Phys.: Condensed Matter, 17 (2005) 7867.

Kaban I., Gruner S., Hoyer W. Monatshefte für Chemie, 136 (2005) 1823.

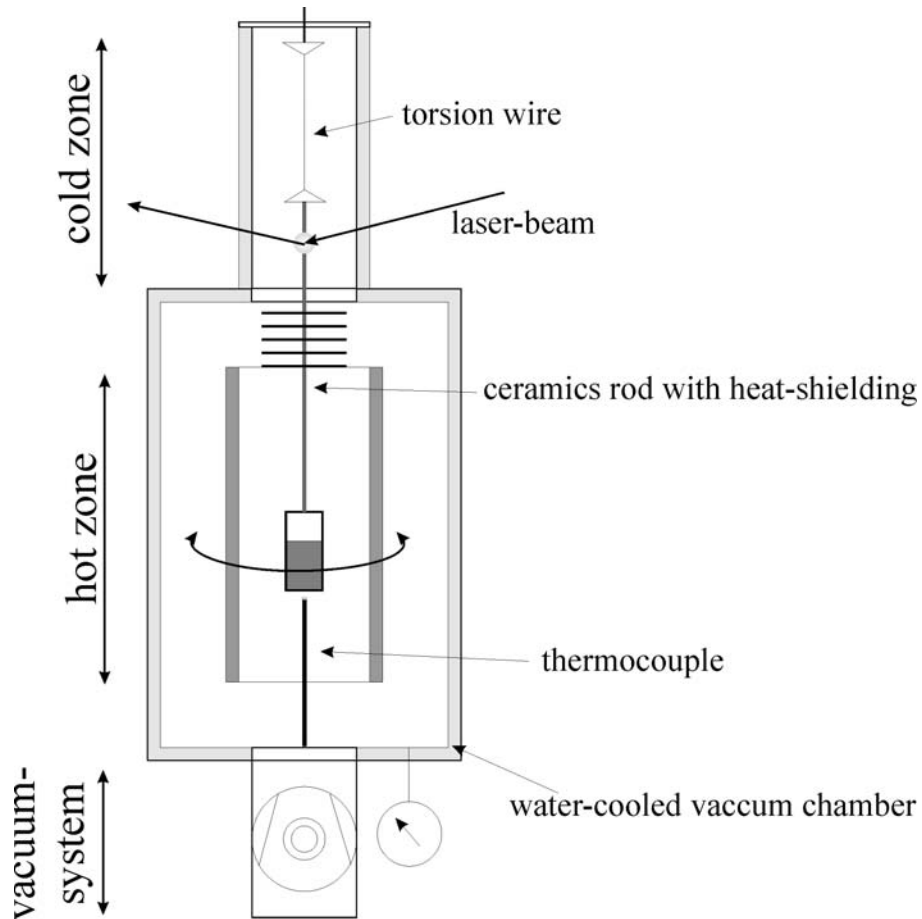
Sn-based solders: density



accuracy: $\pm 1.5\%$

Kaban I., Mhiaoui S., Hoyer W., Gasser J.-G. J. Phys.: Condensed Matter, 17 (2005) 7867.

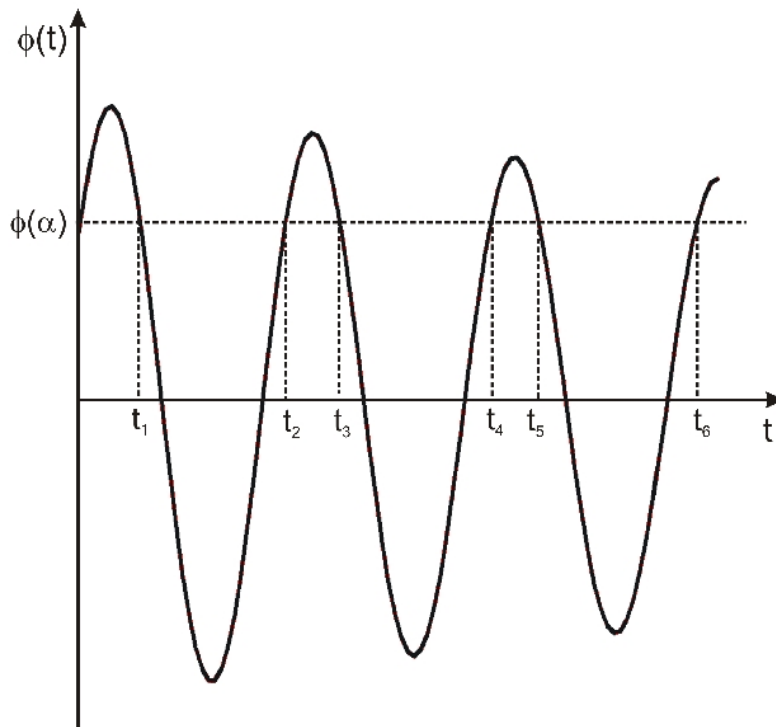
Oscillating cup viscometer



Temperature – up to 1250°C

Vacuum - up to 10^{-6} mbar

Viscosity measurement



Oscillatory motion:

$$I_0 \ddot{\phi} + L \dot{\phi} + f \phi = 0$$

I_0 – momentum of inertia of sample container

f – a constant of torsion wire

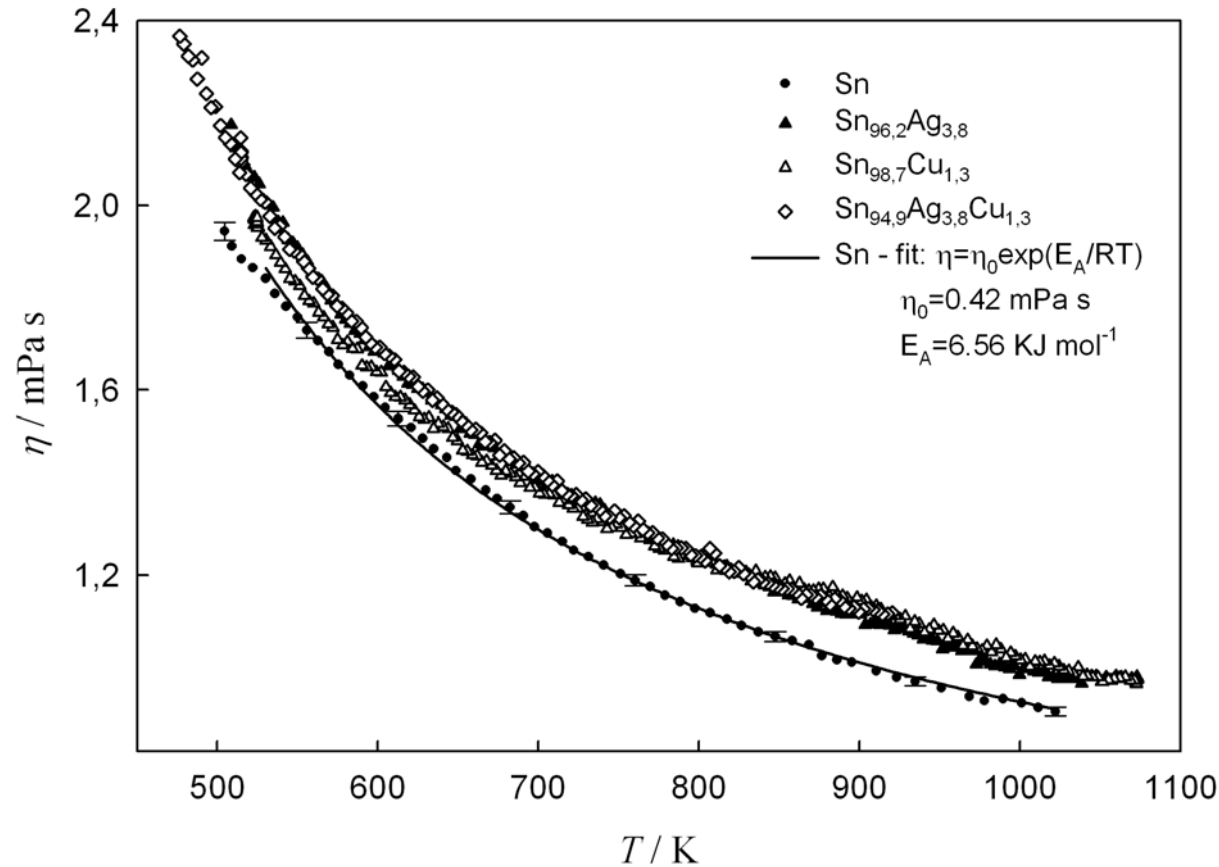
$L = L(\rho, \eta)$

ϕ – time-dependent angular displacement

$$\phi = \phi(t) = \phi_0 \sin\left(\frac{2\pi}{\tau} t + \alpha\right) \exp\left(-A \frac{t}{\tau}\right)$$

Ref.: R.F. Brooks, A.T. Dinsdale, P.N. Queded, Meas. Sci. Technol. 16 (2005) 354.

Sn-based solders: viscosity



accuracy: $\pm 5\%$

Plevachuk Yu., Sklyarchuk V., Hoyer W., Kaban I. J. Mater. Sci., 41 (2006) 4632.

Structure Measurements

- X-ray diffraction (TU Chemnitz, DESY Hamburg);
- Neutron diffraction (ILL Grenoble, LLB Saclay);
- EXAFS (DESY Hamburg);
- Reverse Monte Carlo Simulation.



High temperature diffractometer:

Temperature – up to 1100 °C;

Inert atmosphere – Ar, Ar-10%H₂, He

Kaban, I., Hoyer, W., Il'inskii, A., Shpak, A., Jóvári P. J. Non-Cryst. Solids, 353 (2007) 1808.

Kaban I., Gruner S., Hoyer W., Jóvári P., Delaplane R. G., Wannberg A. Phys. Chem. Glasses, 46 (2005) 472.

Kaban, I., Hoyer, W., Plevachuk, Yu., Sklyarchuk, V. J. Phys.: Condens. Matter, 16 (2004) 6335.

Proposed field of Study:

Ag-Bi-X and Sb-Sn-X alloy systems for high-temperature soldering

- measurement of surface tension, viscosity, density;
- determination of the atomic structure by X-ray and neutron diffraction, EXAFS, Reverse Monte Carlo Simulation;
- correlation of atomic structure and thermophysical properties.

Cooperation:

- Prof. J.-G. Gasser, Metz, France
- Prof. H. Ipser, Prof. A. Mikula, Vienna, Austria
- Dr. Yu. Plevachuk, Lviv, Ukraine
- Prof. G. Borzone, Genova, Italy
- Dr. R. Novakovic, Dr. E. Ricci, Genova, Italy