RESEARCH LABORATORY
FOR DENTAL BIOMATERIALS

Friedrich-Alexander-Universität
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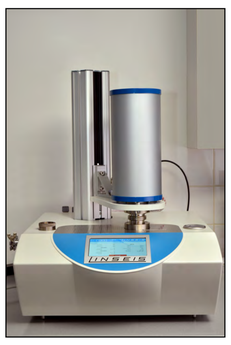
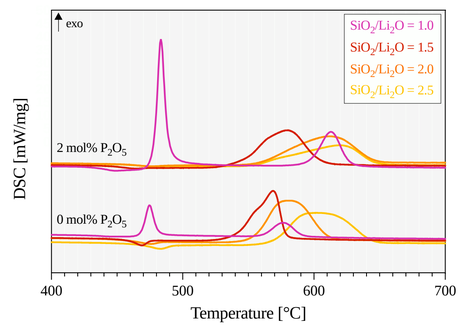
Analytics

Differential Scanning Calorimetry

- Thermoanalytical tool utilised to measure the amount of heat difference required to increase the temperature of a sample and a reference crucible.
- Is used to detect phase transitions, such as crystallization or melting of glasses, which will set free thermal energy (exothermic) or consume heat (endothermic).
- Valuable in determining transition temperatures and enthalpies, thus having great applicability in the construction of phase diagrams.

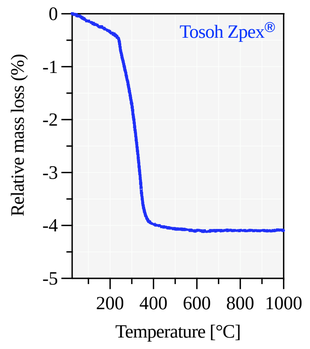




- (Left): DS Calorimeter integrated with a Thermogravimetric Analyser for simultaneous measurements of thermal and weight changes.
- (Right): Typical DSC plots of DSC runs in glasses, showing temperatures of exothermic events.

Thermogravimetry

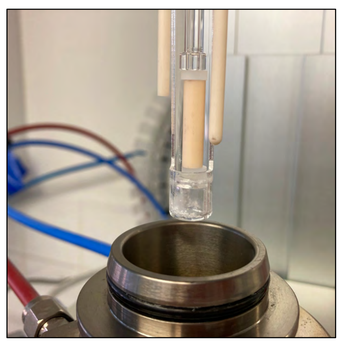
- Coupled to a DSC, a Thermogravimetric Analyser measures precise changes in mass taking place during temperature changes by way of a very sensitive balance.
- It is used to measure mass changes during phase transitions, absorption, adsorption, desorption and thermal decompositions.
- Can be performed in several atmospheres, such as vacuum, air or nitrogen gas, to quantify, for example, water evaporation and debinding temperatures.

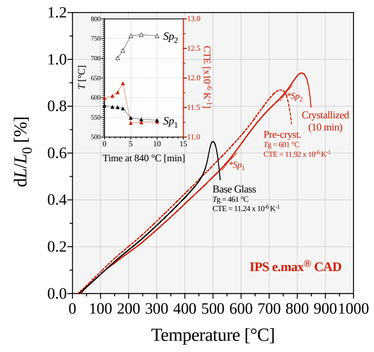


- (Left): TGA balance with two (sample and reference) crucibles which is inserted in a high temperature furnace.
- (Right): Plot showing the relative mass loss of a zirconia granulate during the debinding event at 300 °C.

Linear Dilatometry

- Instrument that combines a very accurate strain gage with a high temperature controllable furnace for measuring changes in physical dimensions with temperature.
- It is used to measure thermal properties such as the linear thermal expansion of materials during heating or cooling schedules.
- It is capable of detecting phase changes such as the glass transition temperature in glasses, along with the melting point due to softening.

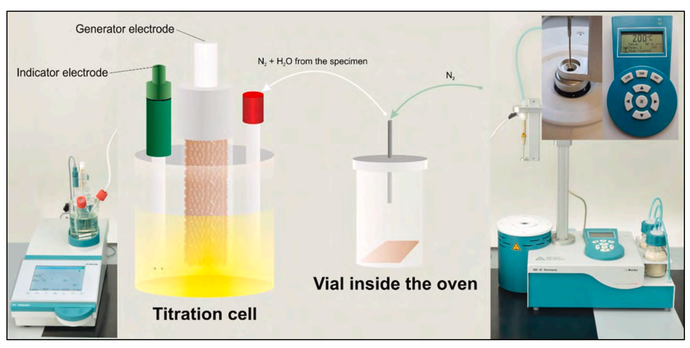




- (Left): Quartz sample holder in a vertical dilatometer containing a cylindrical sapphire specimen.
- (Right): Typical dilatometric plot indicating the relative change in length with temperature change.

Coulometric Titration

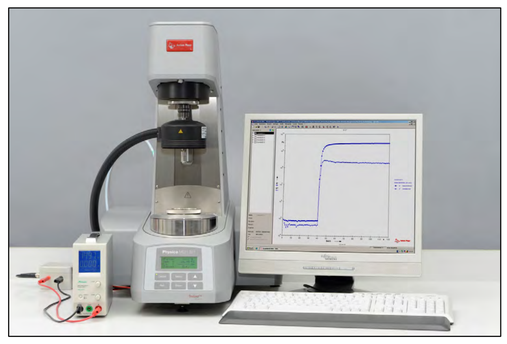
- Karl-Fischer titration is a chemical method used to determine very precise trace amounts of water in a sample based on the oxidation of sulfur dioxide by iodine.
- The titration cell contains a cathode immersed in the anode solution separated by an ion-permeable membrane.
- One mole of I_2 is consumed for each mole of H_2O, with the equivalence point detected by a bipotentiometric titration.



- An oven (right) is used to heat the sample inside the vial. The water vapour released by the specimen is transferred to the titration cell (left) via a constant N_2 gas flow. An empty dry vial is used to condition the system.

Rheology

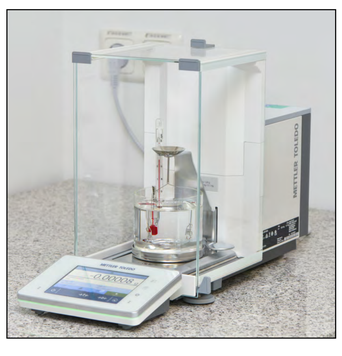
- Rheology deals with the deformation and flow of solid and liquid materials to establish their behaviour under the action of a force.
- It is used to characterise the flow of materials (and its change under stress) so to measure parameters such as viscosity, loss and storage moduli.
- A rheometer uses rotational and oscillating displacements under controlled strain rates to measure the resistance with time or temperature, for example, during setting.

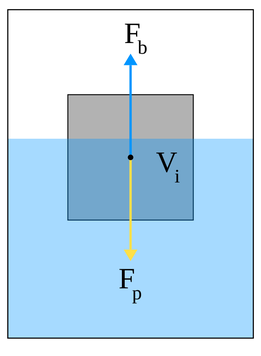


- Rheometer containing peripherial modules for simultaneous tempering (Peltier chamber) and separate photopolymerization for continuous measurement of viscosity parameters during the curing of resin and luting composites, cements, impression silicones, sealers for endodontics root canals, etc.

Volumetric Mass Density

- The measurement of density (specific mass) reflects its mass per unit volume, and is usually done by hydrostatic weighing in a very precise balance.
- Its uses Archimede's principle, which states that the buoyant force that is exerted on a body immersed in a fluid equals the weight of the fluid displaced by that body.
- The measurement using Archimedes' principle requires a special balance with an arm that measures the weight of the material in a container holding the liquid.





- (Left): A very sensitive balance equipped with an arm-tray immersed in water for the measurement of the weight of the object in water.
- (Right): Principle of Buoyancy illustrated for a 2D-cube having an immersed Volume (Vi), the buoyant force (Fb) and the weight of the object (Fp).