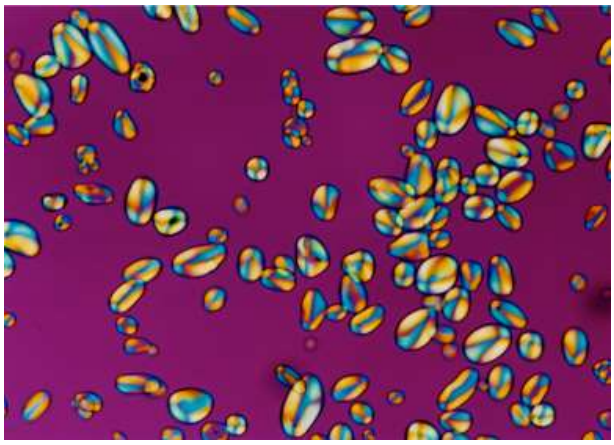
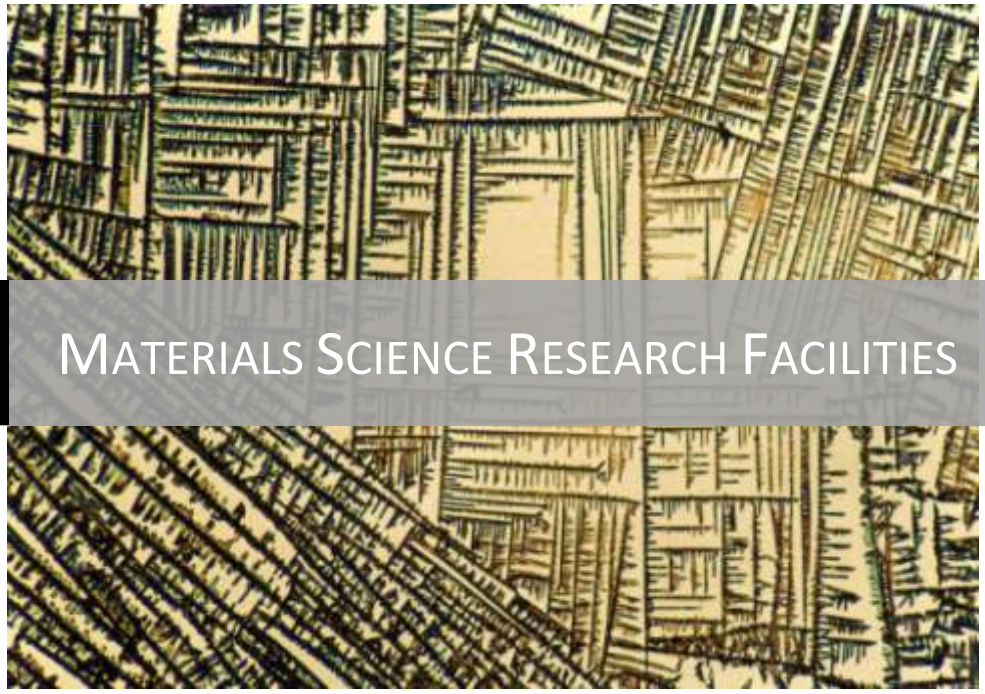
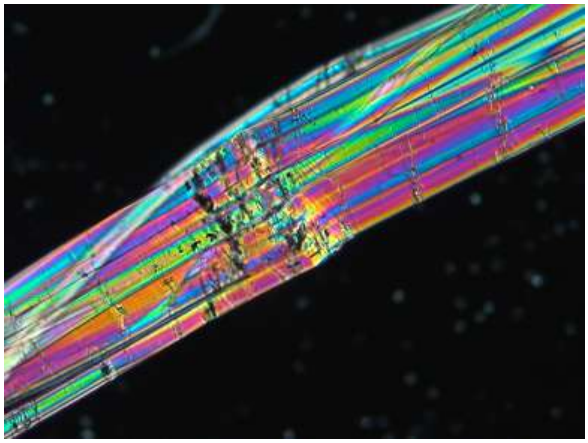
University of the Arts London





UAL

MATERIALS SCIENCE RESEARCH FACILITIES



Introduction/Contents

Introduction:

There is an outstanding range of powerful and up-to-date measurement and test equipment in specialist laboratories at London College of Communication and Camberwell College of Arts, which has been acquired as part of a series of externally-funded research projects.

These facilities are currently available for research collaboration and commercial use.

For further information, please contact:

London College of Communication: Anna Fricker (a.fricker@lcc.arts.ac.uk)

Or Phil Green (pj.green@lcc.arts.ac.uk)

Camberwell College of Arts: Mark Sandy (m.sandy@lcc.arts.ac.uk)

DCA 100 by Camtel Ltd

The DCA 100 is used to measure the tension at liquid/gas and liquid/liquid interfaces. For these purposes the term interface is used to cover the boundary between phases.

Within the bulk of a liquid the molecules are completely surrounded by other molecules such that the forces of attraction are equal in all directions but at the interface there are 'unsatisfied' forces resulting in an inward attraction. This is what causes small drops to assume a spherical shape and soap films to contract.

The universally accepted technique for measuring liquid/gas surface tension is by the Du Nouy ring that has a precise geometry made of Pt-Ir alloy. International standards for both liquid/gas and liquid/liquid interfaces are based on this technique. The standards have been adopted by a number of industries such as water and environmental as well as rubber and surfactants. The measurement simply requires the ring to be wetted by the liquid and then pulled through the interface while measuring the force exerted on the ring.

An alternative geometry for measuring interfacial tension is the Wilhelmy plate that is made from roughened platinum but can be pre-wetted paper or glass with a hydrophilic coating. In this technique the plate is suspended at the interface and maintained in this position by a force that balances the weight of the plate and the meniscus force of the liquid acting on the lower edge of the plate.

One major difference between the ring and the plate is the way in which the measurement is carried out (the ring is moves throughout whereas the plate is static). Therefore there is no 'artificial' disturbance of the interface and no increase in the time to reach equilibrium when using the plate method.

Dynamic Contact Angle Tensiometer, used for measuring the surface energies of solids and the surface tension of liquids.

Differential Scanning Calorimeter

Model Q11 by TA Instruments

The basic principle underlying the technique is that, when the sample undergoes a physical transformation such as phase transitions, more (or less) heat will need to flow to it than the reference to maintain both at the same temperature. Whether more or less heat must flow to the sample depends on whether the process is exothermic or endothermic. For example, as a solid sample melts to a liquid it will require more heat flowing to the sample to increase its temperature at the same rate as the reference. This is due to the absorption of heat by the sample as it undergoes the endothermic phase transition from solid to liquid. Likewise, as the sample undergoes exothermic processes (such as crystallisation) less heat is required to raise the sample temperature.

The Q100 is a versatile, research grade DSC that incorporates the TA patented Tzero™ technology. The Tzero™ cell is designed for excellence in both heating and cooling operation. Its many innovations include a new sensor with raised sample and reference platforms, The sensor is machined for symmetry from a single piece of durable, thin wall, high response constantan and brazed to a silver heating block. These features provide faster signal responses, flatter baselines, superior sensitivity and resolution, plus improved data precision.

Differential Scanning Calorimeter (DSC) measures the temperature at which phase changes occur and the associated energy changes.

Differential Scanning calorimetry (DSC) is a thermoanalytical technique in which the difference in the amount of heat required to increase the temperature of a sample and reference are measured as a function of temperature.

Zeiss Axioskop 40 Optical Microscope/Beckmann Coulter LS230

Zeiss Axioskop 40 Optical Microscope

The Axioskop 40 is an optical microscope used for the examination of specimens at high magnification. The microscope is equipped with both transmitted and incident light illumination capability. The microscope incorporates the following main features:

- High resolution digital colour camera
- 2.5, 5, 10 and 20 magnification objectives
- 10× focusing eyepieces
- 6 position centring nosepiece
- Brightfield, epi-brightfield and polarisation modules
- Circular rotatable polariser
- KL200 cold light source for incident light illumination
- Switchable pinhole diaphragm for conoscopy

Data analysis is achieved using the Zeiss propriety software Axiovision. The system has the facility to set a wide range of parameters for automatic analysis whilst also allowing for manual adjustment.

Beckmann Coulter LS230

Measures particle size distributions for particles ranging from 0.1 microns to 1000 microns. The Optical Module has the following main features:

- Rigid frame containing the sources, lenses detectors and printed circuit cards
- Spatial filter assembly containing a laser diode and laser beam collimator
- Diffraction detector assembly containing a custom photodetector array and beam dump
- PIDS (Polarization Intensity Differential Scattering) assembly containing a tungsten-halogen lamp and filter assembly
- PIDS detector array
- Automatic alignment assembly

The Fluid Module consists of:

- A sample vessel containing the suspension fluid and dispersed sample particles
- A sonicator that helps to disperse the particles
- A variable speed circulation pump that circulates the particles through the sample cell and helps keep them dispersed
- Liquid level sensors

Rheometer: Bohlin CVO

Interchangeable temperature control units ensure that the CVO rheometer can test all sample types, from low viscosity solutions to polymers melts. Features and benefits:

- Integrated, Microprocessor Controlled Electronics
- Automatic Gap Zeroing and Adjustment
- Unique Air Bearing Technology
- Wide Torque Range
- Microstrain Position Sensing
- High Speed Capability
- Controlled shear rate mode

Typical applications:

- Foods
- Coatings
- Polymers
- Adhesives
- Composites
- Pharmaceutical
- Cosmetics
- Petrochemical
- Bitumen

To measure the flow properties of liquid. The CVO rheometer is a flexible rheometer system suitable for research, product development or quality control. Encased within a spill resistant cover with an integral touchpad, the CVO rheometer constitutes a compact unit which is impervious to dirt and fluids.

FTA 200

The FTA 200 is a flexible video system consisting of a measurement platform and a frame grabber (video capture) card running in a personal computer. The standard FTA 200 hardware includes:

- High resolution camera and zoom microscope
- PCI frame grabber card (computer optional)
- Computer controlled syringe pump
- Adjustable specimen stage
- Computer controlled lighting
- Fibre optic drop detector

The system software can measure or calculate many quantities of interest including:

- Static or equilibrium contact angle
- Capillary contact angle
- Advancing contact angle
- Receding contact angle
- Pendant drop surface tension
- Pendant drop interfacial tension
- Sessile drop spreading
- Sessile drop adsorption
- Surface energy from contact angles
- Work of adhesive/adhesion tension

The FTA 200 is used to measure important materials properties such as contact angle, surface tension, surface energy and absorption for adhesives, solders and inks etc.

Spectrometer System

AVATAR 360-FT-IR by Nicolet

The Fourier-Transform technique maximises the signal to noise ratio, and minimises the collection time of a spectrum by simultaneously exposing the specimen to a continuous window of IR frequencies and rapidly deconvoluting individual frequency information with an interferometer and a computing treatment of the signal.

The AVATAR system operates in the mid- and near-infrared region. IR Spectra are typically collected in transmission through KBr disks containing a few milligrams of ground specimen.

The AVATAR system is also attached to an InspectIRTM FT-IR Microanalysis and Video Imaging Accessory that permits measurements of IR spectra by reflection from specimen surfaces, and their microscopic imaging. No specimen grinding is required for this technique.

IR spectroscopy maps the absorption of InfraRed wavelengths by materials. Many of the molecular vibrational modes in materials absorb IR light of concomitant energy. These energies vary with the functionalities, conformation and environment of molecules, thus rendering IR spectroscopy sensitive to the chemical compositions and physical structures of materials.

Bentham Radiometer

The system consists of two diffraction grating assemblies, a reflection chamber with goniometric stage, integrating spheres, a high-sensitivity photomultiplier detector and a variety of light sources.

All optics in the system are UV-permitting, and the system has a spectral range of 200-800nm. A variety of calibrated reflectance and source standards are in use, with direct traceability to national laboratories.

1. In 'camera' mode, the light source passes through a dual monochromator and integrating sphere. The output from the sphere is measured and photographed by a camera, and by analysing the results were are able to determine the spectral sensitivity of the camera.

2. In 'reflectance' mode, the beam from the source passes from the monochromator into the refl ection chamber, where the gonio stage is set for the desired angle of reflectance. A fibre optic cable passes the reflected beam into the second monochromator and ultimately to the detector. Both monochomators are scanned in sync to give the regular relectance from the surface.

3. In 'fluorescence' mode, the system is configured as for reflectance, but the output monochromator is scanned independently of the input monochromator. This allows the fluorescent radiance reflected from the sample to be separated from the regular radiance.

4. In 'gonio' mode, either of the above configurations using the reflectance chamber is used, and is repeated at a series of angles to give the bi-directional reflectance distribution of the sample.

Bi-spectral, bi-directional radiometer, used to measure spectral radiance. The Bentham radiometer is a unique instrument, custom designed and built to provide a powerful and flexible system for investigation of surface and body reflection, fluorescence and emission of light from sources and displays.

Thermogravimetric Analysis (TGA)

Model Q50 by TA Instruments

TGA is commonly employed in research and testing to determine characteristics of materials such as polymers, to determine degradation temperatures, absorbed moisture content of materials, the level of inorganic and organic components in materials and solvent residues.

Differential Scanning Calorimetry (DSC) is a thermoanalytical technique in which the difference in the amount of heat required to increase the temperature of a sample and reference are measured as a function of temperature. DSC is commonly used to identify phase transitions and the temperature at which these occur.

Such analysis relies on a high degree of precision in three measurements: weight, temperature, and temperature change. As many weight loss curves look similar, the weight loss curve may require transformation before results may be interpreted. A derivative weight loss curve can be used to tell the point at which weight loss is most apparent.

The custom-designed furnace on the Q50 features a low mass, rugged heater windings and proprietary heater control technology. This results in rapid, accurate and precise temperature programming over a wide range of temperatures.

The heart of the Q50 is the accurate and ultra-reliable, vertical thermobalance housed in a temperature-controlled environment. It uses the proven 'null-balance' principle, where an optically active servo loop maintains the balance arm in the horizontal reference (null) position by current regulation in a transducer coil.

Two different types of thermal analysis techniques are available. Thermogravimetric Analysis (TGA) is a type of testing that is performed on samples to determine changes in weight in relation to changes in temperature.

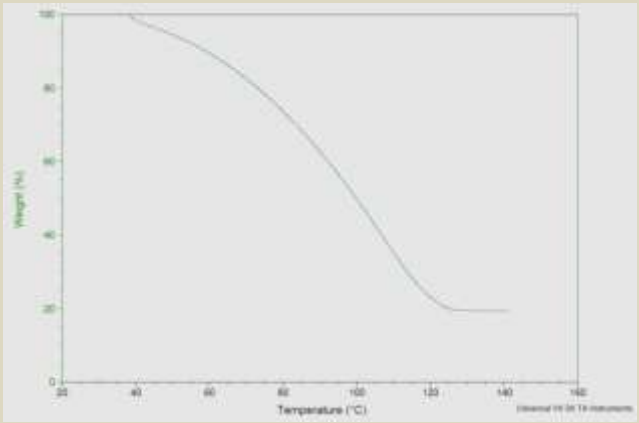
TGA: Case Study

An Investigation Into The Effects Of Solvent Content On The Image Quality And Stability Of Ink Jet Digital Prints Under Varied Storage Conditions

Increasing numbers of galleries, museums and archives are including ink jet printed materials into their collections, and therefore displays. There is evidence that the instability of these prints is such that images can suffer deterioration in print quality or in extreme cases, a loss of information over an extended period of time. This is shorter than the period typically required for perceptible deterioration to occur in other paper-based artworks. The image stability of prints is affected by a number of factors some of which have already been studied. However the role played by the solvent in the loss of image quality has yet to be explored.

This project aims to investigate the effects of solvent content which may promote the loss in image quality of the hard copy prints when stored or displayed under a range of temperature and humidity conditions. Thermal analysis of printed papers is being used to determine the presence of solvent and to quantify the extent of solvent removal.

TGA graph showing the change in weight with temperature



Scanning Electron Microscope

Hitachi S-2600N

The scanning electron microscope is an imaging device used for examining the surface and subsurface characteristics of specimens at high magnification. Image capture is performed via two methods, secondary electron detection (SE) and backscattered electron detection (BSE). The backscatter detector can also be adjusted to observe either topographic images or three-dimensional images.

The SEM can be operated under two conditions, either at high vacuum (HV) or in variable pressure mode (VPM) where the chamber can be pumped to pressures between 1 and 270Pa. Both secondary electron and backscattered electron images can be observed in high vacuum mode. In low vacuum mode, only backscattered images may be observed.

The microscope is accompanied by an Emitech K550X sputter coater which can be used to prepare specimens prior to imaging. The Hitachi S-2600N has the following specifications:

- Resolution:
- SE: 4.0nm (HV)
- BSE: 5.0nm (VPM)
- Maximum specimen size: 60mm diameter
- Working distance: 5 – 35mm
- Accelerating voltage: 0.5 – 30kV
- Magnification range: 15 – 300,000×
- Tilt angle: -20° to 70°
- Rotation angle: 360°

The scanning electron microscope is an imaging device used for examining the surface and subsurface characteristics of specimens at high magnification. The Hitachi S-2600N can accommodate samples up to a maximum of 60mm in diameter.

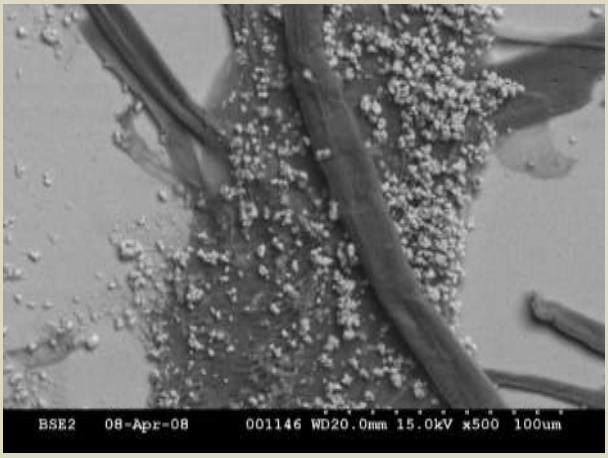
Case Study: Hitachi S-2600N

The Anomalous Effect Of High-Intensity Ultrasound On Paper Fibre-Filler Combinations

This investigation explored the effect of subjecting pulped paper to exposure to high intensity ultrasound. It had been noted that the particle size distribution of fillers and loadings are greatly affected by exposure to ultrasound. A variety of pulped papers were examined and definite trends in the particle size distribution were recorded.

Further examination of the filtrates obtained from the pulps has revealed information as to how the particles of fillers break down and agglomerate together. Scanning electron microscopy was used to provide detailed information at high magnification concerning the presence and distribution of both fibres and loadings in the paper sheet.

SEM micrograph of undispersed PCC filler and short fibre treated with ultrasound



Case Study: Deinking

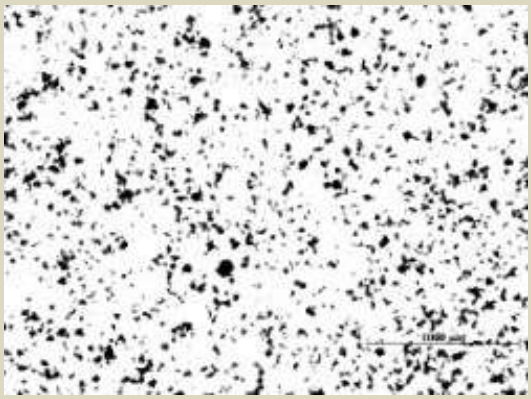
Deinking of Indigo Prints Using High-Intensity Ultrasound

Fears have been expressed about the difficulty of deinking waste paper generated by the Indigo printing process. In this study, high-intensity ultrasound was used to remove ink from Indigo digital printed papers and break the ink particles down to sizes which are compatible with the flotation process used in deinking plants. The influences of temperature and power density were studied and both found to have a significant effect on the resultant ink particle-size distributions. Almost 100% ink detachment has been achieved using a combination of ultrasound and aqueous washing. The conclusion is that detachment and particle-size reduction using ultrasound and aqueous washing suggests that Indigo digital printed papers may not be so difficult to deink and recycle as originally thought.

Optical microscopy was used along with particle counting software to measure the particle size distributions of ink present in handsheets made following ultrasonic treatment. This enabled quantification of the effect of ultrasonic treatment. The particle size distribution of filtrates from the sonicated pulp was analysed with the Beckman Coulter fluid module.

Equipment Used:
- Zeiss Axioskop 40 Optical Microscope
- FFR Ultrasonic Horn (An annular horn is also available)
- Beckmann Coulter LS230

Optical micrograph of a handsheet formed from Indigo-printed paper pulp that had been subjected to ultrasonic treatment



Case Study: Modelling The Spread of Screen Ink

Modelling the spreading of screen ink on non-porous substrates

The reduction of dot gain in half-tone printing is desirable in order to accurately reproduce designs in printed format. An important contribution to dot gain is the spreading of ink on the substrate after image formation but prior to immobilisation by curing or drying. The spreading of a typical screen ink was modelled to determine the thermodynamic processes controlling the rate of drop spreading and the timescales over which they are significant. Suggestions are offered as to the characteristics desirable in polymer substrates in order to minimise dot spreading.

Contact angle measurements were taken to determine the extent of ink spreading over a period of time. The viscosity of the ink is measured with a rheometer to characterise its behaviour.

Equipment Used:
- First Ten Angstroms 200
- Camtel DCA 100
- Bohlin Rheometer

Contact angle measurement of ink on a substrate

Materials Science at University of Arts London

LCC:

By Train: The Elephant and Castle site is connected by Thameslink trains from Blackfriars.

By Underground: Both the Bakerloo and Northern Lines stop at Elephant and Castle. Follow the signs on the underpass to London College of Printing (our former name).

By Bus: Elephant and Castle is extremely well provided for with buses including: 1, 12, 35, 40, 45, 53, 63, 68, 100, 133, 148, 155, 168, 171, 172, 176, 188, 322, 188, 322, 333, 343, 344, 360, 363, 453, 468, C10, P5.

Camberwell:

A large red-brick converted school building, the site is a five-minute walk from the main site. You will see St. Giles Church on the corner where Wilson Road meets Peckham Road, the building's entrance is on your left hand side as you walk up.

By Train: A train from London Bridge, Victoria, or Blackfriars station will take you to Peckham Rye or Denmark Hill which are both approximately 15 minutes walk from the main Peckham Road site. There are also good bus connections to Camberwell from the following mainline London stations: Charing Cross: Bus 12, London Bridge: Bus 35, Paddington: Bus 36/436, Victoria: Bus 36/436, Waterloo: Bus 171, Blackfriars: Bus 63.

University of the Arts London

London College of Communications, Elephant and Castle, London, SE1 6SB.
Camberwell College of Arts, Wilson Road, London. SE5 8LU