Coe College Facilities and Research Equipment

At Coe, we have an extremely large amount of instrumentation for a school our size, an opinion shared by external reviewers. We are a fully research capable group whose equipment is devoted to undergraduate use and instruction. Our equipment base has nearly $2,000,000 in instrumentation bought during the last ten years, with a large increase over the past two years. We have seven laboratory rooms devoted to glassmaking and property characterization (including structural/optical spectroscopy), which include the following equipment:

Sample Preparation: First, we have furnaces: a computer-controlled high temperature (1700 ^{o}C) electric furnace with molybdenum disilicide heating elements, many Thermolyne model 1300 electric furnaces capable of operating up to 1100 ^{o}C, and a Carbolite 1400 °C furnace. In addition, we have a new digitally-controlled Thermolyne tube furnace for crystal preparations. Second, we possess two home-built roller-quenchers capable of cooling melts faster than 10^5 K/s. The roller-quenchers are digitally controlled from 0 to 5500 RPM and have an adjustable gap width which starts at 0.5 microns. Third, we have a brand new professional dry boxes (LabMaster 130, water analyzer with chiller to allow furnace containment) as well as a homemade dry box that uses bottled dry nitrogen, or boil off from liquid nitrogen, depending on the experiment. We also have several high-precision (0.0001 g) digital balances, and an intermediate precision one. We keep on hand an extensive collection of high-quality chemicals for glass making, and various platinum, Pt-alloy, ceramic, gold, and vitreous carbon crucibles. We also maintain the necessary equipment to do solution method glass preparation.

Materials Characterization: Our most recent instrument acquisitions include a Jasco dispersive dual wavelength Raman spectrometer that has been recently upgraded to include mapping capability, a Veeco Scanning Probe Microscope (Nanoscope IIIa with multimode atomic force microscope and fully research capable), an SEM Vega-2 with motorized stage, Oxford INCA-250 energy dispersive X-Ray analysis for elemental determinations and a Bruker X-Ray Spectrometer (D8 advance withautomated sample stage, göbil mirror, and lynx eye detector. We have a brand new thermal suite that includes Perkin-Elmer (N536-0600 hyper DSC lab system, STA 6000) Also, we have a TA Modulated DSC (Q-200) and older but reliably maintained Perkin-Elmer Differential Scanning Calorimeter (DSC-7) and a Differential Thermal Analyzer (DTA-7). We also have a Nicolet Nexus 670 near- and mid-range FTIR, with many capabilities (variable and fixed specular reflectance accessory, pellet holder and maker, polarizer, etc.). To measure density, we employ one of two Quantachrome micropycnometers (one fully automated) which can measure a wide range of densities with sample sizes beginning at about one-quarter of a cubic centimeter. For checking impurities and elemental concentrations we have an Energy-Dispersive X-ray Fluorescence (Oxford Instruments ED-XRF, ED2000 model) spectrometer.

Optical Equipment Our optics research lab has: 1. A Continuum, Q-switched Nd:YAG laser, with doubling and quadrupling crystals and a wavelength separator; 2. A Spectra-Pro 275 mm monochromator with a triple grating turret, including 3 high quality gratings covering the range of wavelengths from 180 nm to 1.5 microns and remote keyboard operation, together with a side window photomultiplier tube; 3. One dual light source (lamp) with 30 W deuterium and 30 W tungsten-halogen lamps, providing a combined output from 190 to 2.0 microns; 4. A SpectraCard computer data acquisition system, running Windows software to control the monochromator and

spectra data acquisition. This offers sampling rates of up to 1000 points per second; 5. A custom-made worktable with added stability and rigidity to minimize vibration and alignment problems; 6. A 4x6' optical breadboard; 7. An Abbe refractometer (range 1.47-1.87), together with a He-Ne laser setup for powder index measurements; 8. A digital thickness gauge with 1 μm resolution; and 9. An Ecomet grinder/polisher with Automet overhead spinning chuck.

The central piece of optics research equipment is our state-of-the-art Comstock Laser Ionization Time of Flight Mass Spectrometer (LITOF-MS), which can measure the masses of molecular groups coming off the glass surface upon UV laser irradiation (nitrogen laser at 337.1 nm) with isotopic resolution. The system is fully computerized for data acquisition and control, and has a separate 125 MHz digital scope for diagnostics.

Other Facilities: The equipment in the shop includes a new lathe, a milling machine, two drill presses, a band saw, tool and die equipment, etc. We also have a part-time machinist to aid us in the work. Other electronics equipment includes a boxcar-averager crate, a digital delay generator, other 125 MHz digital scopes, microcontrollers for teaching and research, and many other items. We have a mid-range computer workstation (Compaq EVO W8000), with the *Materials Studio*® software suite for glass modeling. We also note that in the Chemistry laboratory of Prof. Singleton we have access to a gas chamber in which substrates can be safely exposed to a number of corrosive gases/radicals. Prof. Singleton also has a PE UV-Visible spectrophotometer for our use.

In the research library/lounge we maintain our own database with a current collection of over 1000 research articles, which has been complemented with SciGlass and full access to online scientific journals of interest to glass science. Also, we maintain a large collection of books and journals related to glass science, including hard copies of *Physics and Chemistry of Glasses* and the *Journal of Non-Crystalline Solids*.

The following table summarizes the information and includes the purchase year and brand.

List of Available Research Equipment at Coe College

Instrument (Year)	Brand	Description
Thermal Suite (2008)	Perkin-Elmer	Hyper DSC and STA 6000
Glove box (2008)	LabMaster	Dual box setup model 130 with water analyzer and chiller
X-Ray Diffraction System (2008)	Bruker	D8 Advance with automated sample stage, göbel mirror, Lynz detector
SEM (2007)	Vega	Vega-2 motorized stage, Oxford INCA-250 Energy Dispersive X-Ray analysis
Modulated DSC (2007)	TA	Q200
Scanning Probe Microscope (2004)	Veeco	Nanoscope IIIa with multimode atomic force microscope
Dual wave Dispersive micro Raman Spectrometer (2004)	Jasco	Workhorse instrument for vibrational studies , extremely student friendly

Recirculating Nitrogen Glove Box (2004)	Iowa State University	Fully capable glove box with water levels in the ppm regime
Workstation with *Materials Studio*® software suite (2002)	Compaq Evo 8000	Dual 1 GHz Xeon processors, 2 Gb RAM, two 18 Gb hard drives.
Reflectron Time-Of-Flight Mass Spectrometer system (1997)	Comstock	Capable of high-resolution laser desorption studies of surfaces using a nitrogen laser.
Differential Thermal Analyzer 7 (1999)	Perkin-Elmer	For thermal event characterization to 1650 °C.
Differential Scanning Calorimeter 7 (1996)	Perkin Elmer	For high resolution thermal event characterization up to 600 °C.
Energy-Dispersive X-ray Fluorescence Spectrometer (1999)	Oxford, ED-2000	Can carry out elemental characterization from ppm to wt%, from Na to U.
Fourier Transform Infrared Spectrometer, mid-range (2000)	Nicolet Nexus 670	Wide IR wavelength range, 400-7000 cm^{-1}. Dual detectors, fixed and variable reflectance of solids; capable of s- and p-polarization.
YAG pumped dye laser (2001)	Continuum	Used in laser induced fluorescence experiments
Nd:YAG laser, 2f, 4f (1996)	Continuum	For fluorescence and time of flight studies.
Gated integrator/boxcar (2001)	SRS	For fluorescence lifetime studies
UV-Visible spectrophotometers (2: 2001)	Perkin-Elmer Lambda 35	Wavelength range 190-900 nm; one is temperature controlled.
High temperature furnace (1997)	Thermolyne	For sample preparation, up to 1700 °C.
Ultramicropycnometer (1999)	Quantachrome	Automated, accurate (<1%) volume determination
Roller-quenchers (1993, 1998)	In-house	For cooling rates of 100,000 °C/s.

Instruments Available Through collaboration

In addition to our splendid equipment holdings our students have been able to join experimental team using many additional and important techniques. These include:
--- Solid state NMR of a wide variety of capabilities form 21T magnets on down with state of the art capabilities (MAS, multiple quantum, DAR, and field stepping). The spectrometers are at University of Warwick and Oxford University (UK), University of Manitoba (Canada), Iowa State University (Ames, IA).
---Neutron scattering at ISIS in the UK, on a regular basis. This includes both inelastic (MARI) and elastic (GEM) spectrometers.
---EXAFS at the ILL Synchrotron in Grenoble with analyses done at University of Trento, Italy.
--- ESR spectroscopy at William Jewell College in Liberty, MO.