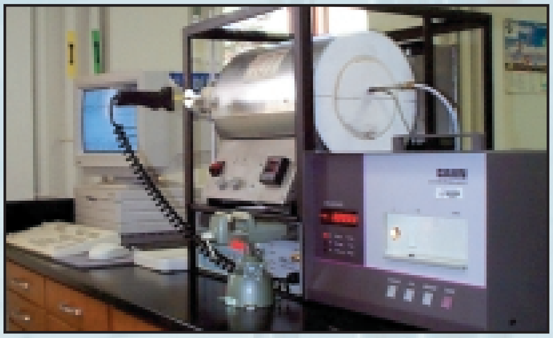
Chemistry and Materials Sciences Laboratory Building 277

The Chemistry and Materials Sciences (C&MS) Laboratory located in Building 277 in the Safety Research and Development area at the FAA William J. Hughes Technical Center provides FAA chemists, fire scientists, and materials engineers the facilities and equipment to develop new fire-resistant plastics and quantify the amount of toxic gas produced during full-scale aircraft cabin fire tests.

The FAA is committed to developing the enabling materials technology for a totally fireproof cabin. The goal of the program is to eliminate cabin fire as a cause of death in aircraft accidents. To achieve this goal we will need interior plastics with an order-of-magnitude reduction in fire hazard compared to current materials. In the C&MS Laboratory, research and development of new, more fire-resistant materials is conducted using state-of-the-art laboratory equipment for thermal analysis, calorimetry, spectroscopy, rheology, surface chemistry, microscopy, and multiaxial mechanical testing. Flammability and combustion parameters of cabin materials are determined in bench-scale fire calorimeters. Prototype components up to 1/2-meter square can be fabricated. C&MS Laboratory equipment includes:

- Perkin Elmer System 7 TGA and Differential Scanning Calorimeter
- Nicolet Magna 550 Fourier Transform Infrared (FTIR) Spectrometer
- Parr Oxygen Bomb Calorimeter for heat of combustion determinations
- FAA Microscale Combustion Flow Calorimeter (patent pending)
- Dionex DX 500 Ion Chromatograph with Thermo-Separations AS 3500 Autosampler
- Rheometrics RDA-II Dynamic Analyzer for rheological testing of fluids and solids
- Instron Model 1125 Universal Mechanical Testing Machine
- Rame-Hart Contact Angle Goniometer for surface chemistry measurements
- PHI Heated Laminating Press–50 Ton/1000°F capability
- Gruenberg Curing Oven–800°F (426°C) capability
- Atlas Scientific Cone Calorimeter for measuring flaming combustion parameters of materials

A unique instrument, the microscale combustion calorimeter, which was developed by FAA researchers, is located in the C&MS Laboratory. The photograph on the next page of the microscale combustion calorimeter, shows, from left to right, the sample pyrolysis stage, the heated oxygen mixing manifold, and the combustion furnace and oxygen analyzer. The calorimeter is used to measure flammability parameters of milligram polymer (plastic) samples under conditions which approximate aircraft cabin fires. The tests performed using the calorimeter provide a quantitative measure of the fire hazard of new materials in an aircraft cabin fire when only research quantities are available, thus



saving the expense of manufacturing and testing large quantities of new materials.

A new, noncombustible material being tested in the C&MS Laboratory is the Geopolymer resin. This material is being evaluated as a resin for use in fireproof aircraft cabin interior panels and cargo liners (see test at right). Geopolymer is a two-part, water-based liquid potassium aluminosilicate resin which cures at 80°C (176°F) to a fireproof solid having twice the density of water. Geopolymer has the empirical formula $Si_{32}O_{99}H_{24}K_{7}Al$. The fire response and mechanical properties of Geopolymer composites were measured and compared to lightweight organic matrix composites and aluminum used in aircraft.

We are using molecular engineering to design "smart" polymers that are tough and flexible under normal use conditions but transform themselves into noncombustible materials in a fire. Two different smart polymers have been designed, synthesized in small quantities, and tested to date: chloral-based polymers and polyhydroxyamides. Both of these polymers have the desirable processing characteristics of commodity plastics in that they are readily soluble in common solvents for casting films and can be molded at low temperature (<300∞C) into impact-resistant seat and cabin parts. When heated in a fire, however, the smart polymers convert to thermally stable, high-char yield materials with the evolution of noncombustible gases, resulting in an order-of-magnitude lower fire hazard than common plastics and resins.

To find out more about the Chemistry and Materials Sciences Laboratory, contact:

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