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Optical Diagnostics for Monitoring MOCVD Deposition of Super-Conducting $YBa_2Cu_3O_{7-x}$ Films

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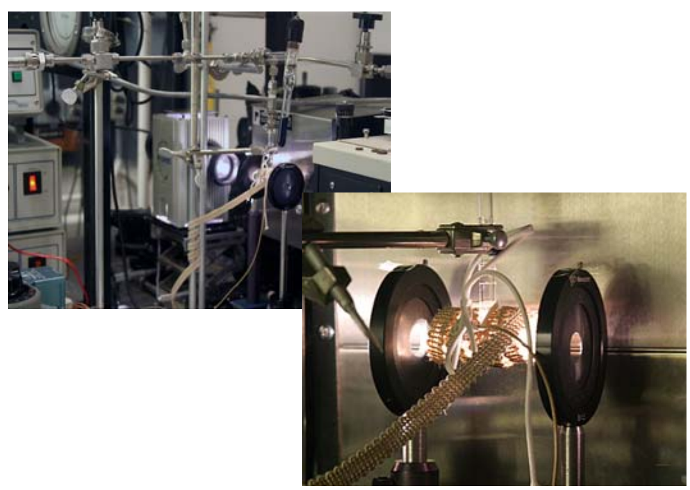
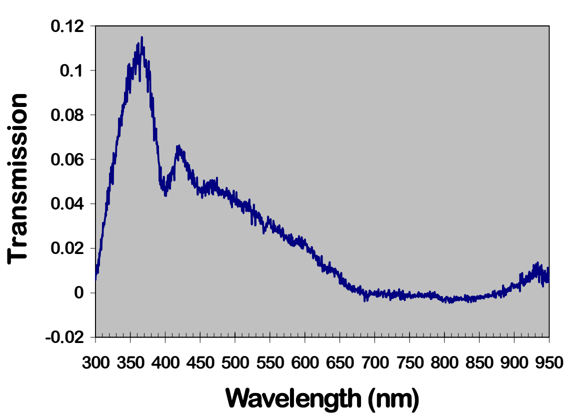
Yttrium barium copper oxide (YBCO) is a high-temperature superconductor (HTS) with numerous applications. For it to be useful in high energy applications, however, it is necessary to be able to create high quality continuous long lengths (1-km) of wire. Currently, two production methods are promising: Pulsed Laser Deposition (PLD) and Metallic Organic Chemical Vapor Deposition (MOCVD). This project is to create a real-time diagnostic sensor for monitoring the production of YBCO by MOCVD.

It is known that spectroscopic analysis of the MOCVD precursor materials will give distinguishable features in the far-IR area of the spectrum (400 to 800 cm-1). However, application of IR spectroscopy to a manufacturing system as a diagnostic sensor is not readily feasible, due to high signal losses (40% over 1 meter) in commercial IR fibers coupled with the low signal intensities generated in that IR range at the operating vapor pressure conditions. IR spectroscopy in the industrial setting would require much improved fibers. So we are attempting to develop a monitoring technique that utilizes the visible range of the spectrum since visible range fibers with low losses (<10% over 5 meters) are currently available. The goal is to find a signal correlation in the visible spectrum that can be used to monitor both the bulk vapor concentration changes and the individual vapor species concentration changes within the deposition environment.

In MOCVD, the feed materials are vaporized and deposited from the gas phase onto the substrate typically in the presence of an inert carrier gas. In the present case, the volatile organic compound, 2,2,6,6 Tetramethyl-3,5-Heptanedionate (thd), is used for the precursors (Ba-(thd), Cu-(thd),Y-(thd), Sm-(thd)) being studied. Our equipment, which simulates a portion of that process, is pictured at right. It consists of a heated glass cell, a light source, a 0.75m grating spectrometer with PMT and a sample cell. The sample cell contains the mixture of precursors in Tetrahydrofuran. The THF solvent is helping to stabilize the mixture along with aiding in the gas phase transfer. The liquid solution is vaporized, then transferred into the evacuated heated glass cell where a light beam is passed through the vapor. The absorption or transmission of the light is recorded as a function of wavelength by the spectrometer.





Samples have been analyzed over temperatures ranging from 25 to 150°C and pressures from 1 to over 110 Torr. The graph at right shows the transmission, plotted as the natural log of light intensity through the gas vapor divided by the light intensity through a empty evacuated cell. This particular sample is at 50 Torr and 140°C. It has promising features around 367 nm and 423 nm. Future work includes analyzing the dependence of transmission on the vapor pressure, temperature, and gas composition in the cell.