Technical Report 001

Laser Flash Photolysis: From Lindqvist to Luzchem

The development of flash photolysis by Porter and Norrish in the late 1940's and 1950's was recognized by the Nobel Prize they shared in 1967. With the advent of the pulsed laser in the early 1960's, many research groups (including Porter, Windsor, Lindqvist, and others) tried to expand the time resolution of flash photolysis into the nanosecond time scale by taking advantage of the short laser pulses available. Lindqvist was the first to achieve this goal (L. Lindqvist, *Hebd. Seances Acad. Sci., Ser. C* **263**, 852-854, 1966), and many of the features of the laser flash photolysis used today can be found in his seminal 1966 paper in which he used a nitrogen laser (337nm) to produce and detect the triplet state of acridine. Early laser flash photolysis systems used nitrogen or ruby lasers and the detection techniques borrowed significantly from the more mature technique of pulse radiolysis. The first computer-controlled laser flash photolysis system was built by Scaiano at the University of Notre Dame in 1977. The Notre Dame system revolutionized data acquisition and processing, and systems of similar design were set up in numerous laboratories, eventually becoming commercially available. In a typical system, the xenon monitoring lamp was pulsed to achieve suitable signal-to-noise using a conventional photomultiplier with 5 or 6 dynods operational (usually 8 are available). Most systems would extend several feet using an optical bench or optical table. Lenses would typically be at least 2 inches in diameter. Multiple electronic control boxes would perform the various operation needed, such as triggering, photomultiplier high voltage, shutter control, etc. Some of these functions would be automated while others would remain manual. In the late 1990's, Scaiano's group at the

University of Ottawa realized the quarter-century old design that had served well in many studies, had gradually become obsolete and that a new generation of laser flash photolysis systems that would take advantage of modern electronic and optical developments of the late 20th century could make laser flash photolysis an easier, more affordable technique.

A partnership between the University of Ottawa and Luzchem Research, Inc. led to the invention of the state-of-the-art miniaturized laser flash photolysis system (mLFP) with a remarkable 12x18 inch footprint including all optics, electronics, and computer control modules. After a quarter-century of service, the Notre Dame design was finally superseded by modern technologies, incorporating many developments reflecting miniaturization requirements in the space and communication sectors.

What is new about Luzchem's mLFP system? The remarkably small footprint reflects major developments in optics and electronics and makes it portable. The modern ceramic xenon lamp contains a built in elliptical mirror that concentrates the light on optical fibers that handle the monitoring beam using miniature collimators. The detector is a red-shifted compact photomultiplier not made bigger than a stack of three dimes. Lamp pulsing is unnecessary given the improved performance of modern components and the system is air cooled. Time scales available start at a few nanoseconds, but extend over many milliseconds since the lamp is not pulsed. Synchronization with the laser is always perfect and jitter-free, since a fiber sensor transmits the trigger information to the digitizer where its pre-trigger function allows baseline collection *before* the trigger signal is sensed. Synchronization is so advanced that the system performs well even with no physical connection between laser and mLFP instrument.

Other advantages of the use of a CW lamp include longer lamp lifetime, better signal baselines, and a more linear detector behavior.

Ultrafast systems, with resolution in the picosecond and femtosecond time scales are now common and powerful tools; however, these ultrafast systems have not replaced the nanosecond instruments as the spectrometers of choice in the study or organic photochemistry, physical organic chemistry, and reaction intermediates.

Luzchem's mLFP has been programmed using LabView and allows full control all monitoring, detection, and data capture features. Designed by researchers for researchers, Luzchem offers state-of-the-art systems at competitive prices. In contrast with systems based on a 25 year-old design, the Luzchem system is sold fully assembled and aligned. Just connect a few cables, aim the laser at the sample and start the mLFP program. From opening the boxes to recording data in just a couple of hours.

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