*Guest Editorial*

# Laser applications to chemistry

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The phenomenon of "light amplification by stimulated emission of radiation" (the laser), discovered over twenty years ago, has become one of the most exciting developments in science. Providing a source of intense, coherent, narrowly monochromatic radiation, with the capability of either continuous generation or periodic flashes of extraordinarily short duration (down to picoseconds), the laser has already had a remarkable effect on research in many diverse areas of engineering and the physical and biological sciences.

Considerable progress has been made in the construction and operation of laser devices, designed to fit a variety of special purposes. Such progress has been described in many articles appearing in *Optical Engineering.* There is also great interest in how laser radiation interacts with various physical and chemical processes, and this field of science is called "laser-induced chemistry." In contrast to the field of laser technology, laser-induced chemistry is in its infancy. Its practical development calls for basic research at a high level of sophistication in chemistry and physics.

In order to acquaint the readers of *Optical Engineering* with the field of laser-induced chemistry, this issue features "Laser Applications to Chemistry," with twelve articles which provide a representative sampling of research at the forefront of this field. A particularly exciting result of the application of intense laser radiation to chemical processes is the absorption of many photons in a short period of time, and the first six articles deal with various aspects of infrared multiphoton excitation of gas-phase molecular systems. The first article by Reiser and Steinfeld addresses the importance of understanding the properties of a laser beam to determine the actual amount of energy absorbed by molecules. The articles by Thiele, Goodman and Stone and by Danen discuss the possibility of selective bond breaking and directing the outcome of a chemical reaction with laser radiation. The articles by Levy, Reisler, Mangir and Wittig and by Nieman and Ronn look at unimolecular dissociation and bimolecular reactions induced by lasers, and how subsequent chemiluminescence can be used to understand the dynamics and coupling among electronic, vibrational and rotational degrees of freedom in such reactions. The articles so far are based wholly or in part on experimental studies; the next article by Leasure and Wyatt presents a rigorous, purely theoretical calculation of infrared multiphoton absorption.

With visible or ultraviolet laser radiation, large amounts of energy can be deposited in molecules by the absorption of only one or two photons, and the following four articles deal with examples of the use of visible laser radiation in chemistry. Resonance ionization spectroscopy is a selective multistep photoionization process which has provided a new sensitive method for detecting small numbers of atoms and molecules, as described in the article by Nayfeh. The use of lasers for spectroscopic studies of alkali metal vapors is rapidly expanding, and this is reviewed in the article by Stwalley and Koch, including possible practical applications such as to sodium lamps. Visible laser radiation can pump electronically excited atoms, and the study of chemical reactions of excited atoms is reported by Solarz, Worden, and Paisner. Lasers can be used to study how certain chemical processes might lead to the development of new lasers, and such a study is described by Bradburn, Armstrong and Davis.

Heterogeneous catalysis plays an important role in the chemical industry, where, for example, the presence of an appropriate solid surface can enhance a gas-phase reaction. The application of laser radiation to heterogeneous catalysis presents new and exciting prospects for both industry and basic research, and experimental examples are provided by Umstead, Talley, Tevault and Lin. Laser-induced desorption and migration of molecular species on solid surfaces represent two key processes in laser/surface catalysis, and the article by George, Lin, Lam, and Chang presents theoretical models for these processes and also for how laser radiation might affect gas-surface collisions.

The guest editor expresses his appreciation to the authors who have contributed to this special issue.