

In another aspect of the present invention, a preferred embodiment of the method includes the steps of generating a visible pulse train at a predetermined narrowband high-pulse frequency; amplifying said optical pulse train and generating a corresponding single narrowband pulse and amplified output; receiving a portion of said amplified train output and generating a tunable visible broadband pulse output therefrom; orthogonally polarizing and collimating said single pulse and said broadband output to generate a focused broadband infrared (BBIR) probing pulse; downconverting and beamsplitting said probing pulse into a horizontally polarized infrared output and a visible pulsed output; passing said horizontally polarized infrared output through a sample and focusing a resultant corresponding broadband signal characterized by said sample; and overlapping said characterized infrared signal with said visible pulsed output to generate a visible spectral signal providing data on said probed sample.

Current and Potential Applications of the Present Invention

Current applications of the invention include detailed mechanistic and kinetic studies of ultrafast processes in chemical and semiconductor systems. Knowledge about rapid energy flow in reactive intermediates of many chemical and biological systems will further our understanding of how chemical reactions occur, what the intermediate species and mechanistic steps in a reaction are, and how energy flow in chemical systems influences the creation of new chemical products. The method should also reveal the structure and energy content of intermediate chemical species as they occur.

Another current application is to examine very short-lived low energy electronic states of semiconductors and metals and to study molecules adsorbed on their surfaces. Direct observation of ultrafast phenomena in semiconductor and metal systems would improve our knowledge of electronic, physical and chemical interactions in such materials and lead to the development of faster electronic circuits and components.

The invention may also be applied to directly observe how electrons migrate through superconducting materials.

Detailed studies in molecular biology, such as the involvement of hydrogen-bonding interactions in RNA and DNA reproduction, protein degradation, and drug interactions with cells and cell membranes could be performed more efficiently by using this method. These time-resolved measurement and their interpretation would eventually lead to the development of new methods to design chemical reactions, catalysts, semiconductor devices and even biological systems.

Still other objects and advantages of the present invention will become readily apparent to those skilled in this art from the preceding detailed description, wherein only the preferred embodiments of the invention are illustrated and described, as aforementioned, simply by way of presenting the best modes contemplated of carrying out the invention. As will be realized, the invention is capable of other and different embodiments, and its several details are capable of modifications in various obvious respects, all without departing from the invention. Accordingly, the drawing and description are to be regarded as illustrative in nature, and not as restrictive, the invention being defined solely by the claims appended hereto.

I claim:

1. Apparatus for obtaining spectrographic data with ultrafast time and high spectral resolution, comprising:
 - means for generating a visible pulse output at a predetermined narrowband high frequency;
 - means for receiving a portion of said pulse output and generating a corresponding tunable broadband visible output;
 - means for orthogonally polarizing, collimating and combining said visible pulse and said broadband output to generate a broadband infrared (BBIR) probing pulse;
 - means for beamsplitting said probing pulse into a polarized infrared output and a visible pulsed output;
 - means for transmitting said polarized infrared output to probe a sample, to thereby generate a corresponding broadband infrared signal characterized by said sample; and
 - means for overlapping said characterized broadband infrared signal with said visible pulsed output to generate a visible broadband spectral signal providing data relating to the probed sample.
2. Apparatus according to claim 1, wherein: said means for generating a visible pulse comprises a picosecond laser source.
3. Apparatus according to claim 1, wherein: said means for generating a visible pulse comprises a femtosecond laser source.
4. Apparatus according to claim 1, wherein: said means for generating said broadband visible output comprises a pumped dye laser capable of providing single high power broadband visible pulses in the picosecond to femtosecond range.
5. Apparatus according to claim 1, further comprising:
 - means for downconverting said combined visible pulse and said broadband output to provide a phasematched broadband infrared output to generate said broadband infrared probing pulse in a nonlinear crystal.
6. Apparatus according to claim 1, wherein: said means for beamsplitting said probing pulse comprises a silicon wafer.
7. Apparatus according to claim 1, wherein: said means for transmitting transmits said polarized infrared output through a sample to thereby generate said corresponding broadband infrared signal.
8. Apparatus according to claim 1, wherein: said means for transmitting transmits said polarized infrared output and reflects the same from a sample to thereby generate said corresponding broadband infrared signal.
9. Apparatus according to claim 1, wherein: said means for overlapping said characterized signal with said visible pulse comprises a second silicon wafer and a nonlinear crystal sum frequency generator to generate the broadband visible spectral signal.
10. Apparatus according to claim 1, further comprising:
 - means for processing said visible spectral signal into spectrographic data characterizing said probed sample.
11. Apparatus for obtaining spectrographic data with ultrafast time and high spectral resolution, comprising:
 - a laser beam source for generating a visible pulse output at a predetermined narrowband high frequency in the picosecond to femtosecond range;