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Laser Ultrasonic and its Preliminaries: An Overview

Pablo Boixb*

Department of Laser Optics, Jobkey University, Mogadishu, Somalia

About the Study

Lasers have been used in most areas of science and technology since their invention in the early 1960s. Therefore, laser techniques are used in areas as diverse as spectroscopy, metrology, inspection, communication, fusion research, weapons systems and surgery. As a light source, the laser has a number of unique properties that together make it a very versatile device. This includes the ability to create an intense, well-collimated beam of coherent light with a well-defined wavelength. Lasers can easily be designed to operate in continuous or pulsed mode (with pulse lengths from milliseconds to picoseconds) and in wavelengths from infrared to ultraviolet. Not all applications take advantage of all the properties of the laser: some (for example, laser welding) require primarily a high-intensity, well-collimated beam that can be precisely focused, while others (for example, interferometry) use the length of exact wave and high coherence. . While lasers have undoubtedly had the greatest impact on optical techniques early on, more recently they have started to make a significant contribution in areas such as ultrasound. Ultrasound is now a broad and mature technology. Ultrasonic testing methods are commonly used for non-destructive testing of engineering materials and structures; ultrasonic diagnostics is commonly used in medicine, while ultrasonic path and dimension measurements are widely used throughout industry. The combination of laser techniques with ultrasound has led to new discoveries and interesting applications. Before moving on to the combination of laser and ultrasound, we will briefly introduce the areas of ultrasound and laser physics separately.

Energy can travel as acoustic waves through solids, liquids, and gases. In liquids, there can generally only be one mode of propagation, longitudinal waves (that is, displacements parallel to the direction of propagation), which take the form of alternating compressions and dilutions; therefore, they are also called compression waves (al). Sound waves propagate at a speed characteristic of the liquid medium. The situation is more complicated for elastic solids, to which the majority of metals belong. Acoustic waves (generated naturally or artificially) cover an extremely wide frequency spectrum. The audible range is approximately 50 Hz at a frequency between 12 and 20 kHz, depending on age, etc. of the individual. Below this range is infrasound, including most of the energy in earthquakes, for example. Acoustic frequencies above about 20 kHz are called ultrasound. Most commercial ultrasound applications are in the 50 kHz 20 MHz range, although increasingly higher frequency measurements are being made up to ~ 100 MHz. Newer acoustic (or ultrasonic) microscopy techniques uses frequencies still higher; H. 200 MHz 2 GHz. Gigahertz frequencies are currently the upper limit for ultrasound. Above these frequencies are quantized lattice vibrations (phonons). Phonon frequencies of phonons in solids typically range up to 1013 Hz. However, for the purposes, we limit ourselves to a restriction to a range below 109 Hz, which can be dealt with in practice by classical mechanics.

Ultrasound can be made to travel relatively long distances in many solids and liquids. In addition to geometric scattering, in the form of the inverse square law in three dimensions, there are a number of medium-specific loss mechanisms, such as absorption by the medium and scattering across discontinuities. All of this causes the signal at to attenuate. Although attenuation can have various origins, it generally increases as the frequency of the ultrasound increases. While ultrasound travels many meters to tens or hundreds of kilohertz in metals, these distances are typically reduced to centimeters much more than 10 MHz. When the frequencies approach gigahertz, the waves only propagate in small fractions of millimeter. Absorption and scattering similarly limit the use of high frequency ultrasound in liquids. In gases such as air, the attenuation is extremely high and propagation paths of only a few centimeters can be achieved if the frequency is raised well above 1 MHz.

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***Address for Correspondence:** Dr. Pablo Boixb, Department of Laser Optics, Jobkey University, Mogadishu, Somalia; E-mail: pablo.p.boix@uv.so*

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