Science and Technology

Energy Saving Technology and Extremely High Output Laser Technology

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Background of Research

50 years have already passed since laser technology was born in 1960. It can be said that the history of Olympic Games is pursuit of the limit of human abilities of strength, speed, etc, while the history of laser is competition of human technologies for bringing the strength of light power or shortness of light pulse to the limit. It may not be an exaggeration to say that its history is repetition of build and scrap operations of a huge proportion.

The laser technology, which has been long regarded as a representative player of large energy consumption and light source unfriendly to the human body, is now gathering attention as the trump card of an energy saving measure for preventing the global warming or a light source that is friendly to humans. For example, the technology for the processing of silicon that supports solar cell technology or sapphire that supports energy-saving white LED lights is indispensable for energy saving development, and at the moment, the laser technology is the only effective means for processing these products. Also, terahertz wave generated by converting the wave length of high output laser is now attracting attention as a light source friendly to the human body eventually to replace X-ray that has been long used as a non-destructive inspection light source.

We have developed high-intensity, high-output, high-quality, low power consumption laser as a new laser limit technology for pioneering the above energy saving technologies.

Achievements of Research

The laser we are developing now is high-output picosecond (10-12 seconds) laser. This laser which has all such performances as high output (92 W), high intensity (>10 MW), high repeat rate (1MHz) and high beam quality is an innovative laser which overwhelms for the first time in the world the performances of the currently commercially applied picosecond laser. The key characteristics of picosecond laser are lower cost, lower power consumption, and higher pulse repeat rate in comparison with femtosecond (10-15 seconds) laser exemplified by titanium sapphire laser or, in short, lower photon cost (unit energy cost of light) by almost two figures.

This laser really addresses the needs of our energy saving era. Around 2000 when we began the development, we were often asked, “why picosecond laser”?

In Japan at that time, the femtosecond laser technology was holding sway in the field, and the development of picosecond laser was a surprising topic. Now we can say the time is catching up with us. The grooving processing of silicon or sapphire has been already proved. By using our laser technology, ultra-speedy processing of a few meters per second is possible.

The key technology that supports our research is a special mirror called phase conjugate mirror and a laser amplifier with extremely high gain which is called side excitation vanadate bounce amplifier. Phase conjugate wave is light that shows the space inversion characteristics of incident light, and this light automatically compensates various phase distortions generated in a laser device. For this reason, we have been able to maximize the effective use of the high gain, the strongest advantage of side excitation vanadate bounce amplifier which has large phase distortion, for the development of breakthrough laser. We have been funded by competitive support programs such as Precursory Research for Embryonic Science and Technology, Grants-in-Aid for Scientific Research and Seeds Manifestation, and we have been also featured in media including the Nikkan Kogyo Shimbun. I have been invited to give more than 10 speeches inside and outside Japan in the past two years.

Prospect of Research

In the future, the wave conversion from visible to ultraviolet ray will be an important turning point. In this wavelength region, the absorption of silicon or sapphire is larger than near-infrared light by one digit, and thus the work efficiency can be remarkably improved. We are also thinking about using deep ultraviolet or terahertz light as an excitation light source. In addition, we deem it also important to improve the reliability, space saving and power consumption of laser by widely adopting laser optical systems which have been quickly advancing lately.