OPTICOPHYSICAL MEASUREMENTS

CONCEPTS FOR A CURRENT STANDARD FOR LASER ENERGY METERING

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A brief survey is presented on the foreign laser market in 1997-8 and laser system applications. It is necessary to upgrade laser metering metrological support systems, and there is a discussion of setting up and using a new generation of standards. Descriptions are given of block diagrams, working principles, and engineering characteristics of promising standards for the units of laser energy and mean power.

Laser systems are increasingly used in many areas abroad [1, 2]. Experts performed a detailed analysis of the foreign laser market in 1997 [2] and made a forecast for its development in 1998. As most laser firms had a stable economic situation in 1997, there was a considerable increase in the profits from sales of laser engineering. The sales volume for all types of lasers on the world laser market in 1997 attained 3.22 billion dollars, i.e., an increase of 14% by comparison with 1996. The sales volume in terms of number of items increased by almost 26%, which indicates that laser prices fell. These tendencies are due, on the one hand, to increasing competition and, on the other hand, to the increase in sales in categories such as sealed CO2 lasers.

The forecast for 1998 also envisages an appreciable increase in the profit from sales with a slight reduction in the increase in volume in terms of items. It was anticipated that in 1998 the total world profit from sales would increase by 19%, with the sales volume in dollars for diode lasers almost equal to the sum of the sales for all other types. It was anticipated that the rise in sales in terms of items would be 14%.

The total world profit from sales of all types of lasers other than diode ones in 1997 was 1.4 billion dollars, which corresponds to the forecast made in 1996. It was expected that in 1998 the sales volume for these lasers would attain 1.7 billion dollars.

The sales volume for diode lasers in 1997 was slightly below that expected and constituted 1.83 billion dollars. For 1998, it was forecast that the increase in sales volume would be almost 17%, with the increase in number of items 14%.

The most substantial area of application for nondiode lasers and systems remains in material processing. This sector includes lasers for labeling and processing metals, for processing semiconductor and microelectronic components, for the rapid manufacture of experimental items by stereolithography, and for systems for making components and providing micromechanical processing [2].

It is anticipated that there will be an ongoing increase in laser sales volume for processing materials throughout the world. For Europe and Japan, it is forecast that the increase in sales for these lasers will be by 20%, while in the USA it will be 15%.

The main increase in profits in the medical laser sector in 1997 continued to be provided by cosmetic applications. The total profit from sales of medical lasers (not systems) as used in ophthalmology and general surgery increased by 14% in 1997. It was anticipated that in 1998 the profit from sales of all nondiode lasers, which constitute about 94% of the total profits from medical lasers, would increase by 13% [2].

There is also expected to be an ongoing increase in sales of excimer lasers in terms of items during the next two years, but with an overall reduction in the profit from sales from 80 million dollars in 1997 to 69 million dollars in 1998.
The sales volume for ophthalmological argon lasers has been adversely affected by the gradual replacement of argon lasers for photocoagulation by systems based on YAG:Nd lasers involving frequency doubling, as well as laser diodes. Therefore, the total sales volume of medical ion lasers in 1998 will continue to fall, whereas it is expected that there will be a sharp rise (by 400 items) in the sales volume for diode-pumped solid-state lasers.

Preference has been given to YAG:Er lasers in recent years for various procedures in dermatology, dentistry, and ophthalmology. In 1998, the sales volume for these systems for treating skin and dentine should more than double [2].

These figures have been derived by tracking sales of medical laser equipment. The forecasts on sales profits are based on the sales volumes for medical systems in which a laser is only one component. However, the figures are based on the sales volumes for lasers used in medical equipment.

Some familiar laser suppliers produce medical instruments and supply them directly to users. In some cases, medical firms that sell laser-therapy instruments either make the lasers themselves or buy them from laser makers.

In 1997, the annual profit from selling all types of laser for scientific research should have increased by 6% (to 150 million dollars), whereas in fact in 1997, the sales volume decreased by 6% and constituted 132 million dollars. It is suggested that the sales volume will increase by 4% in 1998.

Diode-pumped solid-state lasers as before occupy the leading position in the market for lasers for scientific research. According to the forecast, in 1998 their sales volume should increase by 112%. Commercial models have been developed for high-power continuous-wave solid-state lasers having output power of 10 W in the green spectral region, which has meant that they can be used as pumping sources for scientific research systems. In spite of their prices, these lasers are more promising from the viewpoint of cooling and power drawn than analogous ion lasers.

For the first time in recent years, there has been a slight rise in sales volume for lasers for monitoring and measuring instruments not only in monetary terms but also in numbers. In 1997, the total annual profit in this sector was planned to fall by 3% on account of reductions in laser diode sales volume there. In fact, the sales volume increased by 5%, and for 1998 it was forecast that the volume would increase by 21%.

The sales volume for nondiode lasers in the market for monitoring and measuring instruments was 44 million dollars in 1997; in 1998, it should increase by 22%. In terms of number of items, the sales volume should also increase (by about 18%).

This sector of the laser market includes not only ordinary analytical instruments but also ones for molecular biology (for example, for researching DNA). In those areas, it is forecast that there will be approximately equal increases in sales profits from nondiode lasers.

In 1997, there was a considerable increase in sales of diode-pumped solid-state lasers for biomedical purposes. The growth rates were 38%, although these were much less than the forecast 76%. For 1998, it is expected that there will be a considerable increase in sales growth rates for these lasers (by 65%), but a more moderate increase (by 38%) is forecast for analytical instruments.

The annual profit from sales of ion lasers in that sector increased by 15%, although the increase was much larger in terms of items. The difference in sales reflects the relatively greater age of this technology and the state of the competing market: the average prices for instruments with more well-established technology have fallen more rapidly because sales in terms of items have increased.

He-Ne lasers represent a promising low-cost radiation source, particularly for biomedical systems that employ visible radiation at various wavelengths. For 1998, it is forecast that sales of these lasers will increase by 18% in monetary and numerical terms.

The 1997 forecast for sales growth for all types of lasers used in lidar and location systems was extremely optimistic at 38%, but in fact the growth was only about 13%, with total sales of 27 million dollars. The picture was even worse for nondiode lasers. The profit from these lasers in 1997 was 30% below the forecast. In 1998, it is planned to increase the sales volume by 12%.

The largest rates of increase in sales (83%) were forecast for diode-pumped solid-state lasers. Nevertheless, the growth rate for lamp-pumped solid-state lasers was 9%. As in many other areas, high-power cheap and convenient solid-state diode-pumped lasers may increase the market for lidar and location systems. Until recently, sales in that sector were held back by the high cost and large volume of the lasers.

Less than 1% of all lasers go into systems for checking, measuring, and monitoring purposes. The rise in profit from lasers in this sector began in 1996. In 1997, the profit from nondiode lasers in that sector was about 17 million dollars, which corresponded to the forecast. In 1998, it was anticipated that there would be a further rise of 18% in profit, mainly as a result of a 28% increase in sales of diode-pumped solid-state lasers.