How to stay on Top of Solid-State Laser Development

A visit to Coherent's Luebeck facility, a center of excellence for solid-state laser manufacturing

Today solid-state lasers are plug'n play devices, with long lifetime and high reliability. This has become possible through rigorous quality control and semi-automated production. Andreas Thoss met Reinhard Luger, general manager of Coherent's site in Luebeck where precise manufacturing technology has become a key to success.

LASER TECHNIK JOURNAL: Luebeck is famous for Marzipan, not for lasers. But looking at your 70.000 sold systems, you are obviously quite good in making lasers. What sort of systems do you produce here?
Luger: We mainly manufacture for two different sectors. One is low power, lower price and high volume CW lasers which produce visible beams. These are used mostly in medical diagnostics, such as biomedical instrumentation. The second sector is high power, higher price and lower volume specialty UV lasers, where the product's performance, lifetime and overall quality stand out.

LTJ: How does the product range fit into the whole Coherent picture?
Luger: In Luebeck, we started our laser activities with the development and manufacture of visible CW lasers. This was in the mid Eighties. These lasers were of diode-pumped, solid-state type, a technology we still focus on today.

Coherent has a business unit structure and drives many different technologies including semiconductor lasers, excimer lasers, solid-state lasers, more technologies than any other laser company does. Each business unit defines its own technology and product road map, with which it envisages success. In Luebeck for example, we drive business on four different product technologies and all are diode-pumped solid-state laser based.

LTJ: What do you develop here on-site, and what do you manufacture?
Luger: Everything we develop in Luebeck is also manufactured exclusively here. This is Coherent's philosophy. We believe this is the quickest way to access the market for particularly complex products. The closeness to the developers is of great significance during the manufacturing process.

LTJ: To put it bluntly, just about anybody today can produce solid-state lasers. What makes you so special? Why is this particular location so successful?
Luger: I would disagree with the statement. Anyone can make low performance DPSS lasers, but very few can make the products we make. Even fewer can make them reliable enough for 24/7 operation for years – that is why Coherent enjoys such a prominent position in the market. Our OPSL and the Paladin technologies make us very unique and differentiated. The key is always differentiated performance and reliability. We continue to make investments which result in lower costs. These investments mean significantly improved quality of our end products. For example, in Luebeck we now use semi-automated manufacturing. We have developed manufacturing processes where, with the help of robots, we can economically produce very high-quality products. Using these types of methods, taken from the electronics manufacturing sector, contributes significantly here. This enables solid manufacturing, consistent production and increased reliability.

LTJ: I found it very interesting looking at the laser manufacturing process. Most amazing was that you solder your optical components onto a ceramic substrate.
Luger: This is one of our patented technologies we call PermAlign. The ceramic substrate, which is the laser resonator plate, comes with electric circuitry and solder pads. The solder is heated via the circuitry. The optical components are placed into the liquid solder of a pad, aligned to optimum and then frozen in this position. The result: optimal alignment and stability over the whole lifetime of the laser plus outstanding unit-to-unit consistency. All this is not achievable with standard techniques for mounting optical systems.

LTJ: Looking back ten or fifteen years, diode-pumped solid-state lasers were already being built. What would you see as the most important change in development of the last ten years?
Luger: For Coherent, it is the know-how we have gathered which enables production of very durable UV lasers. This means that our UV lasers now have a service-free lifetime of several years. This was not possible ten years ago. Hands-free operation of high-power UV lasers over thousands of hours is one of the keys for our success, especially in the microelectronics market.

THE PERSON

REINHARD LUGER

Dr. Reinhard Luger studied Engineering (TU Munich) and graduated in the field of material science (RWTH Aachen). After some years in R&D (Heraeus) he moved to sales and marketing and finally General Management of midsized businesses. He managed equipment manufacturers in the field of medical, material testing and semiconductor metrology before joining Coherent. He joined Coherent GmbH in Luebeck, Germany in 2000 as the General Manager.

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LTJ: And with CW lasers?
Luger: If you look at the CW visible laser, it is actually a platform strategy. Right from the outset we built a platform that enables scalable performance and wavelength flexibility. It allows us to quickly satisfy all market demands, which can change fairly quickly without having to make large-scale changes to our technology. So on the one side, we have many years' experience of components and manufacturing technology. On the other, we can modify our products relatively quickly to comply with particular requirements.

LTJ: You are also active in the semiconductor sector. Your customers are all located in Asia, however. Why are you still based in Germany?
Luger: That's a good question. Of course we have to meet the challenge of getting closer to our Asian customers. We have recently made an offer to acquire Hypertronics (Singapore & Malaysia). This acquisition will help us to get more involved in Asia with the addition of a depot repair center and manufacturing plants. It may also lead to more customer-specific development for our Asian customers, and may improve the supply chain to the Far East. This could also mean moving the manufacturing of products to Asia. This cannot be ruled out anymore. We are based in Germany due to availability of highly skilled talents. Germany is a powerhouse in engineering and specifically laser skilled graduates. Not to forget the strong public funding into lasers and optics at universities, institutes (e.g. Fraunhofer) and laser centers.

THE COMPANY

Coherent Inc.
Coherent designs and manufactures a broad selection of lasers and supplies electro-optic instruments for laser test and measurement. The company's products include laser diodes and laser diode systems, carbon dioxide (CO_2) lasers, excimer lasers, ion lasers, CW and Q-switched DPSS lasers and systems, ultrafast lasers and amplifiers. The company provides worldwide service and applications support.

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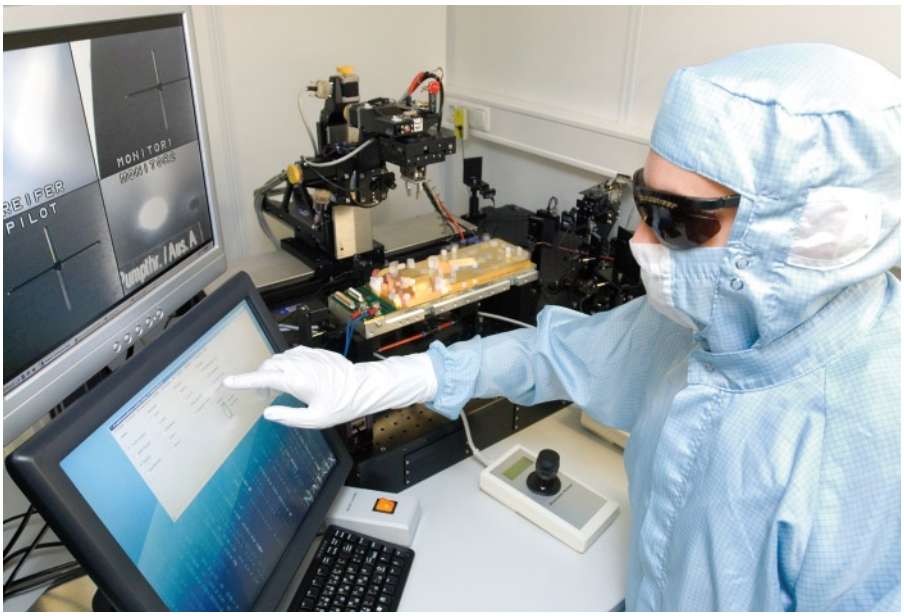

Semi-automatic production and alignment in a class 1000 clean room.

LTJ: But you are going to stay here.
Luger: We are definitely staying. As you see, we are currently extending our production capacity with a further clean room building. We are not so concerned that we will no longer be producing here. We are actually more worried about managing fast market cycles and coping with expansion pressures.

LTJ: If we could just come back to the technical aspect. Could you tell me which current technology trends you find most interesting?
Luger: We should again differentiate between visible CW lasers on the one hand and high-performance UV lasers on the other. Our real challenge is the miniaturization of the CW visible lasers which will reduce costs even further. Biomedicine is showing a tendency towards this type of application, relating to Point of Care. Technology allows increasing closeness to the patient, and this in turn requires that diagnostic systems be ever smaller. So the lasers have to be smaller, consume less power – think of battery-powered systems -, and so on. This will be a big challenge in the future, so of course we are working on this.

The high-performance lasers are measured by dollars per Watt. Here the question is how can we improve performance without increasing costs or how can we get cheaper products without compromising performance? We think that improving performance at the same price is the way to go. So we are looking at improving our products' performance.

LTJ: In recent years, there was a tendency towards beam-source geometry which departed from standard diode-pumped laser geometry. By this I mean disk lasers and fibers. Would you also invest in such technologies?
Luger: That is definitely something Coherent is investing in and you should be expecting more fiber based products in future years. They are not the ultimate solution for all laser types. The promise of fiber is lower cost due to elimination of the mechanical resonator and access to specific interesting operating regimes that are hard to obtain from solid-state crystals. That means they will have clear niches of success but will not be the applicable technology for all areas.

LTJ: If we can now look at applications for your products. What are the main application areas?
Luger: The main application areas for CW lasers are bioinstrumentation and medical diagnostics, and for the high-performance laser it is in microelectronics. This classic differentiation suits us well. Bioinstrumentation and medical diagnostic systems relate to life sciences. The aim of this can be expressed as "we want to lead a more comfortable life, we also want to become older". Medicine technology and especially analytical technology in the pharmaceutical industry require both high performance and cost effective systems. The latter is especially important, as the systems usually end up in the doctors' own clinics. And there is a further trend: many clinical systems need to be simplified and miniaturized in order to be used closer to the patient.

Laser-based tool for solar cell production. Up to three separate laser sources can be integrated from the Paladin, AVIA, and Talisker product families.

Looking at Microelectronics, mobile computers or PDAs represent our most significant growth area. In this market sector, we are bombarded by so many applications of which three would be semiconductor inspection, PCB manufacturing and solar cell efficiency enhancements.

LTJ: Try to tell us about two or three of the most important ones anyway.

Luger: From our point of view, it is advanced packaging and integration. Ultimately it is about forming 3-D connective pathways. Usually a laser is needed for this. We also see useful applications in thin films processing. This relates, for example to flat panel display and solar applications, where we need effective and low-cost thin film production processes.

LTJ: If we also observe markets from a regional perspective – where do your products go? And what is the trend?

Luger: Again we have to differentiate here. Visible CW lasers are very often employed in the pharmaceutical sector. The North American and European markets are definitely the most important, although things are changing in Asia, where there is rapidly increasing growth. North America is still the largest market, even bigger than Europe.

In microelectronics, Asia is clearly our target market. By this we don't mean that we sell directly to customers in Asia. Rather, we have strong connections to integrators in Europe and North America. Integrators and mechanical engineering are, in my opinion, a great starting point for German laser producers to break into Asia.

LTJ: Looking at the Asian market, they were far behind in laser technology. There are rumors that this is changing. How do you rate the Asian competition?

Luger: They represent a real threat in the low end and low performance space but that is not where Coherent plays. We focus on high added value and highly differentiated high performance applications where our 45 years of knowhow, IP and application knowledge is still a formidable barrier for newer Asian companies to overcome. The play for Coherent is to always be moving the performance and reliability barriers forward at a pace that is greater than the learning of any of our competitors.

Actually, this is what we are doing. In instrumentation, we are strongly investing in manufacturing technology, supply chain and miniaturization. In microelectronics, this means understanding performance and UV technology better than anyone. This is our approach to it.

LTJ: Ultimately, nobody wants to be the proverbial rabbit in the headlights, always focusing on Asia. Actually the American photonic expert output is considerable. Isn't there much more technological competition coming from there?

Luger: We have had this for the last twenty years, so nothing has really changed. I believe that Coherent compares very well with American competition. The new challenges are from Asia, and this requires a new tact. It will take them another decade or more to become truly competitive in all spaces. And by that time it will result in a reasonable cost equalized market, so the overwhelming cost advantages Asia enjoys today will lessen as the years go by.