ICV TAnK
Technology Advisory & Knowledgebase

Laser Applications in Quantum Science and Technology

Market Research Report

Oct. 2023

Foreword

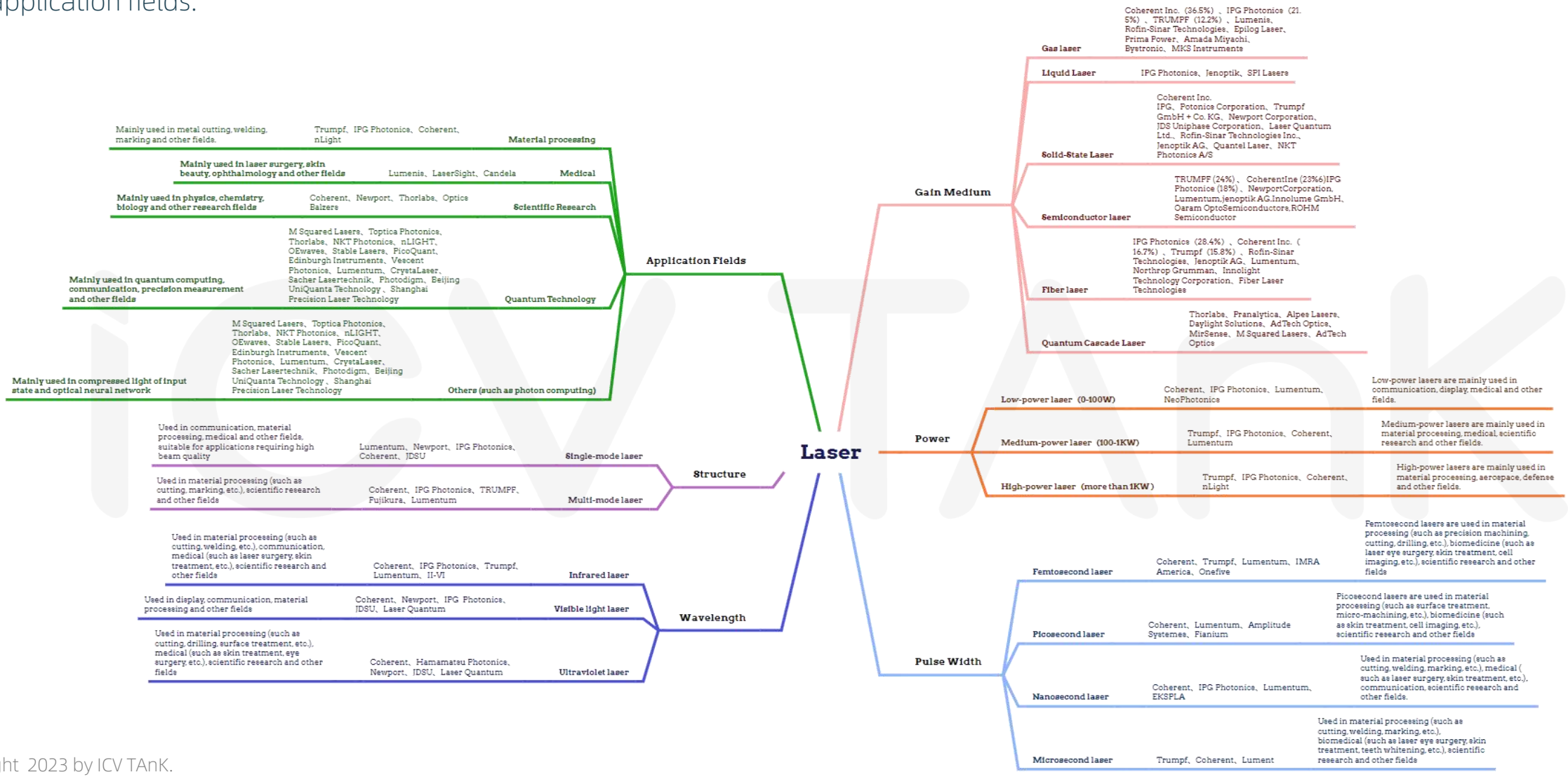
Quantum science and technology is a frontier field in the scientific community, which involves using the principles and phenomena of quantum mechanics to achieve new functions and applications. The development of quantum science and technology relies on high-precision, high-efficiency and high-sensitivity laser equipment, to manipulate, measure and entangle quantum systems, such as atoms, photons and electrons. The important role of lasers in the quantum field has been verified and demonstrated in many experiments and theoretical studies.

This report aims to introduce the application status and market prospects of lasers in quantum science and technology, divided into the following five chapters. The first chapter mainly introduces the basic knowledge of lasers, and how lasers can realize various operations and control of quantum systems. The second chapter will turn to the development status of quantum computing, and how lasers can help build, run and optimize quantum computers. The third chapter introduces the development status of quantum communication, and how lasers can facilitate the secure transmission and sharing of quantum information. The fourth chapter introduces the development status of quantum sensing, and how lasers can improve the performance and accuracy of sensors. Fifth chapter analyzes the main participants in the global laser market in the field of quantum science and technology, as well as their products, markets, strategies and trends.

This report hopes to provide readers with a comprehensive and in-depth understanding of the important role and huge potential of lasers in quantum science and technology, as well as the related market opportunities and challenges. We believe that this report will provide valuable insights for scientists, engineers and entrepreneurs, and contribute to promoting the application of lasers in the quantum field.

Classification of Laser

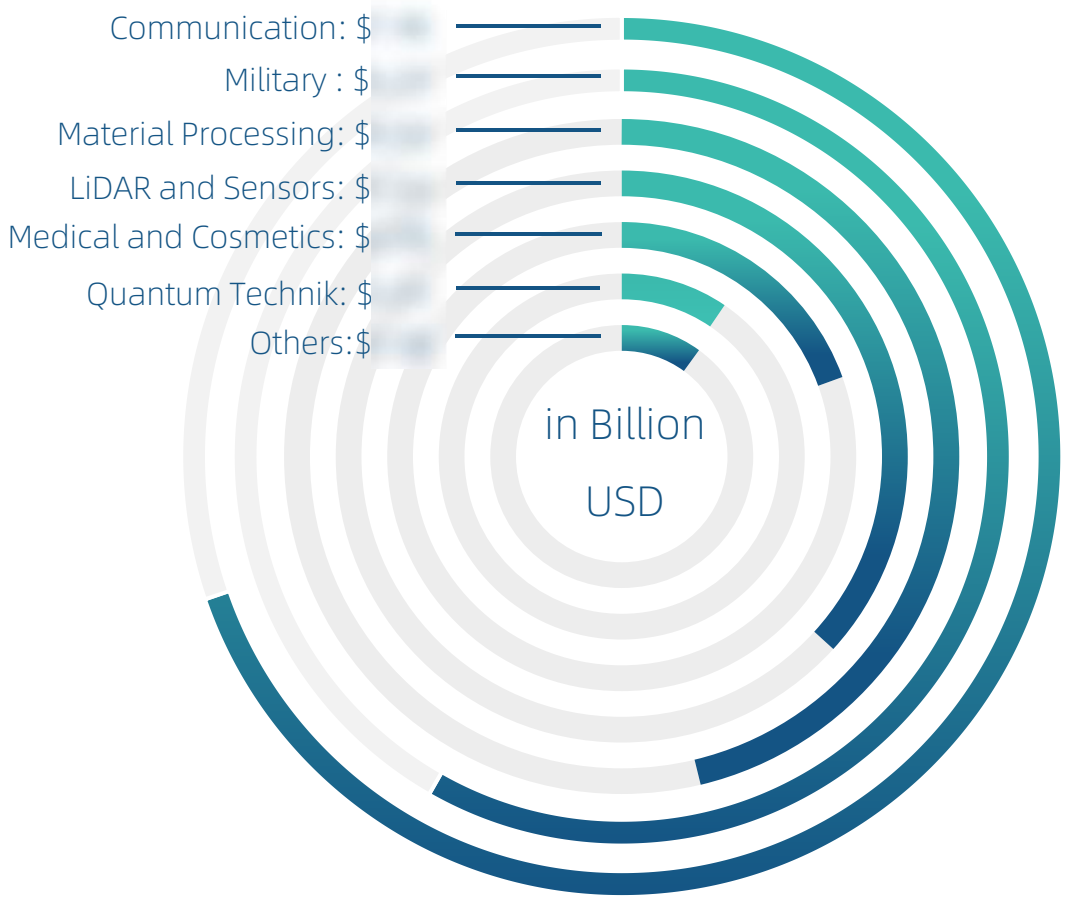
Laser systems can be classified based on six common parameters: Gain Medium , Power , Pulse Width, Wavelength, Structure, and application fields.



Applications of Laser Market

The global laser market size is projected to have a diverse distribution across various applications by 2026. In the communication sector, lasers are anticipated to contribute significantly, with an estimated market size of $ billion. The material processing industry is also expected to be a major driver, with a market size of $ billion. LiDAR and sensors, which play a crucial role in autonomous vehicles and environmental monitoring, are projected to reach a market size of $ billion. The medical and cosmetics industry is expected to have a market size of $billion, leveraging lasers for applications such as surgeries and skin treatments. Quantum technology, an emerging field with immense potential, is estimated to have a market size of $billion. Other applications, combined with military applications, are forecasted to reach a market size of $ billion, highlighting the wide-ranging uses of lasers in various sectors. These market sizes reflect the growing significance of lasers in enabling technological advancements and driving innovation across multiple industries.

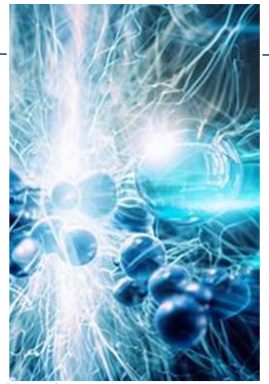
Global Laser Market Size by Application (2026E)



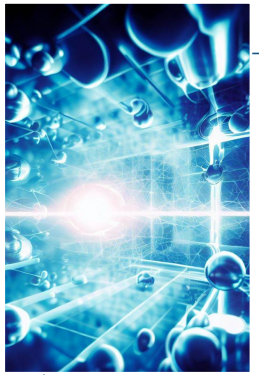
Lasers in Basic Quantum Technology

Lasers are vital in basic quantum technology, including:

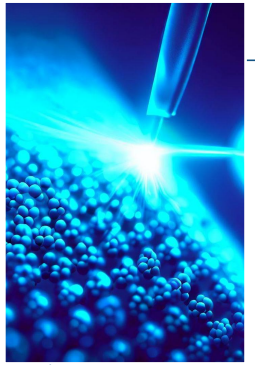
•Atomic Cooling and Trapping: Lasers cool and trap atoms to ultra-low temperatures, enabling precise control for quantum experiments and applications.



•Light Pumping and Electromagnetic Induced Transparency: Lasers optically pump atomic systems and induce transparency, enabling control of light-matter interactions at the quantum level.



•Ion Cooling and Trapping: Similar to atomic systems, lasers cool and trap ions, allowing for precise control of their quantum states.



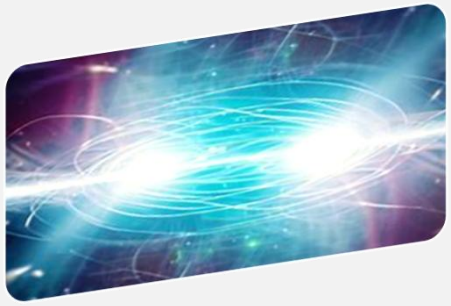
•Quantum Dots and Microcavities: Lasers facilitate the study of quantum dots and microcavities, which have applications in controlling individual photons and enhancing light-matter interactions.

Laser for Quantum Communication

Lasers have important applications in quantum confidentiality communication, including quantum key distribution (QKD), satellite and fiber optic communication, and quantum invisible transmission.

1.Quantum Key Distribution (QKD): QKD uses lasers to transmit quantum keys, which are individual photons carrying quantum information. Lasers generate and manipulate these photons, ensuring their quantum properties are preserved during transmission. QKD allows secure key exchange between parties by exploiting quantum mechanics principles. It alerts the parties to any potential eavesdropping attempts, as intercepting or measuring the photons would disrupt their quantum states.

1.Satellite and Fiber Optic Communication: Lasers play a crucial role in secure quantum communication over long distances. In satellite communication, lasers transmit quantum keys between ground stations and satellites, establishing secure channels. In fiber optic communication, lasers encode and transmit quantum information through optical fibers. By leveraging laser properties like coherence and low noise, reliable and secure quantum information transmission is achieved over extended distances.



1.Quantum Invisible Transmission: Quantum invisible transmission aims to conceal the presence of transmitted quantum information from potential eavesdroppers. Lasers encode quantum information into specific carriers, such as photons with specific wavelengths or polarization states. These carriers are transmitted alongside classical signals, making it difficult for eavesdroppers to distinguish them. Quantum mechanics principles and laser technology enable covert transmission, enhancing the security of confidential communication.

Laser Industry Summary

Industrial lasers are trending towards increased power and beam quality to meet diverse application requirements.

For quantum cascade lasers, the development focuses on:

- Enhancing power and efficiency to meet broader application needs
- Improving wavelength tunability for different scenarios
- Achieving integration, such as chip-level integration, for smaller size and higher integration

Fiber lasers, which utilize fiber as the laser medium, have the following future development trends:

- Increasing power for higher precision manufacturing
- Reducing size to accommodate various applications
- Lowering cost for wider adoption

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