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High channel count and high precision channel spacing multi-wavelength laser array for future PICs

SUBJECT AREAS:
SEMICONDUCTOR LASERS
INTEGRATED OPTICS
FIBRE OPTICS AND OPTICAL COMMUNICATIONS

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Multi-wavelength semiconductor laser arrays (MLAs) have wide applications in wavelength multiplexing division (WDM) networks. In spite of their tremendous potential, adoption of the MLA has been hampered by a number of issues, particularly wavelength precision and fabrication cost. In this paper, we report high channel count MLAs in which the wavelengths of each channel can be determined precisely through low-cost standard μ m-level photolithography/lithographic, lithography and the reconstruction-equivalent-chip (REC) technique. 60-wavelength MLAs with good wavelength spacing uniformity have been demonstrated experimentally, in which nearly 83% lasers are within a wavelength deviation of ± 0.20 nm, corresponding to a tolerance of ± 0.032 nm in the period pitch. As a result of employing the equivalent phase shift technique, the single longitudinal mode (SLM) yield is nearly 100%, while the theoretical yield of standard DFB lasers is only around 33.3%.

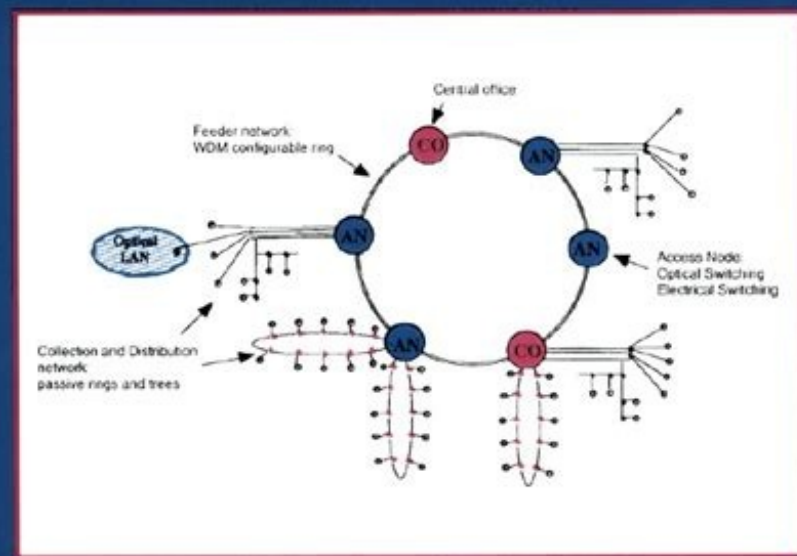
Since the proposal of the concept of photonic integrated circuits (PICs), tremendous progress has been made. In 2005, Infineon Corp. rolled out the first commercial PICs, in which hundreds of optical functions were integrated onto a small form factor chip for wavelength multiplexing division (WDM) systems¹; and a monolithically integrated 5×100 Gb/s WDM chip has now been demonstrated. Despite the advances made in recent years, there are still some general challenges associated with PICs, such as materials², integration of the isolators³, and ultra-low-cost fabrication⁴. Of the issues indicated above, the critical issue to be addressed is how to increase the integration density at a very low cost. Multi-wavelength laser arrays (MLAs) with a high channel count are considered to be an engine of PICs, but high-volume production of MLAs with accurate wavelength control and low manufacturing cost remains a huge challenge. Currently, the distributed feedback (DFB) lasers used in MLAs are fabricated using electron beam lithography (EBL), which offers high resolution fabrication but low throughput because of the long writing time⁵. It is also well known that EBL suffers from drawbacks such as handling or deflection errors and shaping errors. Very few references have discussed the non-uniformity of the wavelength spacing of the devices fabricated using EBL. In Ref. 6, it is shown that using EBL, only 35% lasers have a wavelength variation of less than ± 0.2 nm. To the best of our knowledge, this is the most recent paper reporting a statistically significant data set concerning wavelength accuracy. Ref. 7 shows that the error associated with the EBL process may be as large as 3 nm. No further reports with detailed information are available. Such issues greatly affect the yield of WDM PICs and significantly increase the manufacturing cost.

The yield and cost of DFB laser arrays are considerably different from those of individual lasers. At present, the manufacturing cost of an individual laser is very low. However, when the yield is 80% for an individual component, the yield of a 60-laser array is only around 0.0015%, and the cost will be several tens of thousand times more than that of the individual lasers, which makes it impossible to manufacture high-channel-count, monolithically integrated WDM chips. Furthermore, the fine wavelength tuning required for each channel can only be accomplished using a sophisticated chip structure and complex auxiliary systems, leading to extra power consumption and degraded laser performance⁸.

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OPTICAL WDM NETWORKS

Principles and Practice



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Mobile Fronthaul
Transmode's unique passive, semi-passive and active options enable mobile operators to migrate to Cloud-RAN architectures

Introduction
As data capacity in networks continues to rise at an exponential rate, mobile operators are looking for new architectures that can handle this demand. Cloud-RAN architectures, which separate core and edge functions, offer a number of advantages. They provide a more flexible and scalable architecture, reduce operational costs, and improve network performance. They also enable operators to take advantage of the latest technological innovations in network equipment and software.



Orthogonal Frequency Division Multiplexing OFDM

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Vehicular Technology Conference - 2004

Textbooks and References

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Fiber Optics For Broadcast Video Applications
Eric Fankhauser
V.P., Advanced Product Development
evertz
Fiber Optics

- Need for Fiber Optics technology is constantly increasing
 - Driven by increasing data rates
 - Declining implementation cost
- Many advantages
 - Extremely High Data Carrying Capacity
 - Low signal attenuation
 - Free From Electromagnetic Interference
 - Lightweight

When boosted by Erbium doped fiber amplifiers (EDFAs) and Raman⁹ amplification two performance improvement technologies for high speed communications¹⁰ the range of these DWDM systems can be extended to work over thousands of kilometers. Wavelength Division Multiplexing (WDM) is a technology that multiplex multiple optical signals into a single fiber using different wavelengths, or colors, of laser light to transport different signals. With DWDM, suppliers have found several things techniques for cramming 40, 80 or 96 wavelengths of fixed spacing in the C band spectrum of a fiber. As such, many networks designed for 10 and 40 Gb/s are now carrying 200 Gb/s channels, and many that have been deployed with flexible network capacity are now carrying 400 Gb/s signals and up to ≈ 800 Gbps! Ciena offers complete DWDM solutions to meet customer needs, from edge to core, in a flexible range of platforms. The report also presents the regional analysis of opportunity graphics along with the expected market size and forecasting analysis for several sub-segments of the WDM market. Traditional DWDM line systems use wavelength selective switches (WSS) designed with fixed filters of 50GHz or 100GHz. The report analyzes the growth rate and penetration of the optical transport network in all major regions. CWDM is used for short-range communications, so it employs wide-range frequencies with wavelengths that are scattered far away. In large part, there are three types of WDM sub-technologies, namely BWDM, CWDM and DWDM. Standardized channel spacing allows space for wavelength drift as lasers heat and cool during operation. As the need for information increased, so did the need for wider ed ed siaicini sepaÅareg ed siano radomoc otio ed ahil ed sametsis setsE .arbit rop sovita adno ed sotnemirpmoc otio ed sonem moc MDW sametsis rop odinifed © Å MDWC Å:MDWC(ossory MDW :ejoh MDW ed sopit siod metsixE .adnab whose wavelengths require less than 50 GHz or 100 GHz of spectrum (depending on the filter used). Over time, advances in optoelectronic components allowed the design of systems that simultaneously transmitted light wavelengths on a single fiber, significantly increasing fiber capacity. The WDM's global market report analyzes the global adoption tendencies, future growth potentials, the main drivers, the restrictions, opportunities and practices recommended in this market. The relation also examines The growth potential, market sizes and revenue predictions in different regions, as well as user segments. One of the best features of DWDM deployment on a flexible football line system is the independence of signal "the ability to support several transponders generations independently of format, bits, symbol rate, etc. Wavelength Division Multiplexing, or WDM, is a system of fiber transmission that uses multiple wavelengths of light to send data through the same medium. Å Å Indeed, Å Å coherent modems of the last generation of today are so intelligent and programmable that the modern considers a greater variety of constellations and baud options, allowing a extremely granular affinity. The report provides a comprehensive analysis of the boosters, restrictions, opportunities and challenges of the market. As an example, the popular CienaTM Å Å Å Å 6500 packet platform takes advantage of the latest technological innovation to offer new levels of scale, flexibility and programmability in three comprehensive networks for service provision Customizable to any distance. With the increasing use of the Internet by residential users, the need for WDM solutions in metropolitan regions has become stronger, and therefore CWDM emerged as a alternative technology. Here we consider the DWDM for the long-course land market and we consider only CWDM / Roadm for the metropolitan market, since some solution providers use CWDM and some Roadm to provide an optical transport network Marketplace. It offers the full range of CWDM and DWDM solutions in a totally agile and instrumented photography system,

including support for CDC Roadmaps of flexible grid, with DWDM solutions ranging from 10 GB / SA 800 GB / S . Today, flexible channel plans are possible, allowing anything from channels 64 x 75GHz or 40-45 channels for larger, 800g rates à € à € ø leverage a flexible (or gridless) grid architecture that supports channels with a size 37.5GHz minimum with adjustable 6.25GHzÀ € à € ø "to accommodate any available channel today or in the future. The bandwidth technology segment is still categorized into five types, namely until 10 Gbps wavelength, 10 Gbps wavelength, 40 Gbps wavelength, 100 Gbps wavelength and more than 100 Gbps wave length . Notes in this market, which contribute to the largest participation, include Alcatel-Lucent, Ciena Corporation, Cisco Systems, Inc., Huawei Technologies, ZTE, Fujitsu Ltd., and Infinera Corporation. During the DA © Each of 1980, IMptical fiber data communication modems used low-cost LEDs to put infrared pulses for low-cost fiber. But this ability was quickly exhausted. The WDM market research report highlights the market potential in different regions, such as Northern Americans, Sia-Pacific (APAC), Europe, Latin America and Men's East and Africa (MEA). For a robust operation of a system with densely packaged channels, high precision filters are required to remove a specific wavelength without interfering in neighboring wavelengths. DWDM systems should also use precision lasers that operate at a constant temperature to keep the channels on the target. CWDM is a compact and economy option when spectral efficiency is not an important requirement. 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