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OPTICAL SIGNAL PROCESSING

PERIODIC POLING KEEPS LIGHTWAVES IN PHASE

Periodic poling sounds more like a strategy for a Venetian gondolier than an opto-electronic switch matrix designer, but it may be the key to the future of high-speed optical networks.

Lightwaves can be transmitted regardless of their polarity over standard fiber-optic cable. However, at very high rates of speed in the 40 Gb/s range where frequencies are packed closely together, the transmission of lightwaves suffers from a phenomenon called polarization dispersion. In an opto-electronic switch, where light traveling down one waveguide path needs to be precisely and quickly transferred to a different path, polarity mismatches can cause significant signal degradation.

In theory, the waveguide substrate in a switch could be designed to slow down and speed up waves of light so that they remain exactly in phase and are not lost. That is precisely what Srico, Inc. (Columbus, OH), achieved with SBIR funding from the MDA as well as the U.S. Air Force, National Science Foundation, and NASA. The company developed a proprietary method of modifying opto-electronic waveguide substrates to provide an optical switch that is polarization insensitive and has negligible polarization dependent loss.

In 2002, MDA awarded a Phase I SBIR contract to Srico to prove the feasibility of a high-speed switch matrix in a new periodically poled lithium tantalate (PPLT) optical waveguide substrate. Periodic poling is a modification technique that can be applied to a variety of substrates, but lithium tantalate was chosen for investigation because of its unique properties and in the hope that it might overcome some of the limitations of lithium niobate for switching voltage and speed. Srico successfully designed a high-speed switch using the new technique and PPLT material. Most recently, in 2003, MDA funded Srico to extend the periodic poling technique to a new class of lithium niobate wafers called stoichiometric lithium niobate.

What exactly is periodic poling? In a lithium tantalate crystal, lithium, tantalum, and oxygen atoms repeat in the same sequence, and as a result the crystal has a uniform property everywhere. With periodic poling, however, alternate sections of the crystal have the opposite structure for these atoms, which reverses the properties of the crystal for that section. The alternating sections of poled regions serve the purpose of slowing down and speeding up lightwaves so that they remain in phase.

The use of affordable opto-electronic switches and add/drop multiplexers operating reliably at processing speeds above 100 GHz would abet the deployment of 40 Gb/s networks and ease deployment of fiber links directly to residences. However, telecommunications is not the only broadband use for periodically poled waveguide substrates. Any application requiring high processing speeds, such as computing and sensors, might benefit from the availability of high-speed opto-electronic switches.

Srico provides technology development and integrated optic circuit design services for clients and to the U.S. government, and currently manufactures opto-electronic switches in prototype quantities. The company seeks either to license its existing patents or to find one or more strategic partners to fund and further investigate the characteristics and reliability of devices that use periodically poled substrates for volume manufacturing.

—A. Gruen

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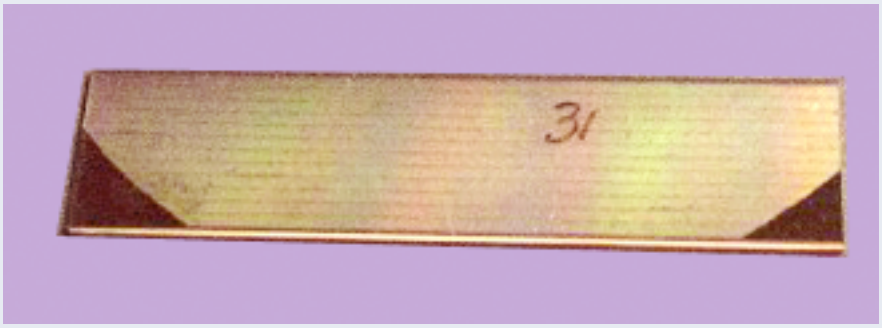

PPLT. *Srico's optical waveguide substrate made of periodically poled lithium tantalate forms the basis for a high-speed opto-electronic switch.*