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Electronics

Crystal-clear Imaging

Wideband radar-signal processor could enhance security, surveillance.

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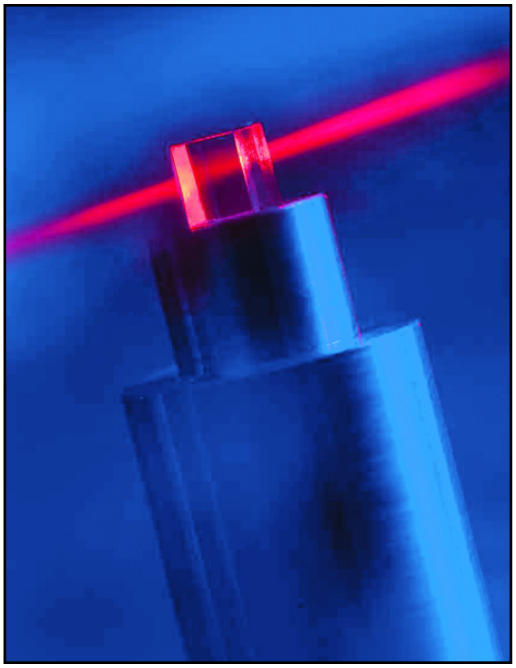
A new MDA-funded radar-signal-processing system could give radar operators, intelligence officials, and port security officers the new powerful imaging tools that they are seeking.

S2 Corporation (Bozeman, MT) is using patented optical memory materials to develop a signal processor that can identify targets more readily using instantaneous wideband waveforms, resist signal jamming, and operate over a broad dynamic range. This processor can potentially handle bandwidths of tens of gigahertz. It is also designed to deliver extremely precise results in applications that involve ranging or Doppler radar.

S2 has developed a hardware prototype for the radar signal processor, which company researchers call the S2RSP. S2 officials expect the prototype to be tested in house, at the Massachusetts Institute of Technology's Lincoln Laboratories, and by the contract's administrator, the U.S. Army Space and Missile Defense Command, by the end of this year. S2 also expects this technology to receive Technical Readiness Level 5 certification during the same period. Following tests, the company plans to design an application-specific production model before the contract expires, anticipated in 2009.

The company's recent work on the device has been funded by a multimillion-dollar MDA SBIR Phase III contract. MDA also funded development of the original optical memory materials on which the company relies. Those materials were developed by Scientific Materials Corporation (SMC; Bozeman, MT) under an SBIR Phase II contract.



▲ S2's device digitally reprocesses laser-modulated radar signals stored in patented optical materials. The technology could give users constant wideband reception with extremely precise results over a large surveillance area.

FLIR Systems acquired SMC in November 2005, with S2 spinning out of SMC as a separate company. FLIR Systems continues to provide high-quality optical-memory materials to S2 Corporation. Some of the prior technology was patented by researchers at Montana State University. S2 Corporation maintains exclusive licenses to these patents and also claims several trade secrets under SBIR data rights.

At the heart of the S2RSP is a specially grown and cryocooled crystal—into which are written holographic representations of modulated analog radar signals. These spatial-spectral, or S2, crystals have been proposed for possible use in radar applications since the beginning of the decade, when SMC's Phase II contract was in play.

The S2RSP is designed to operate as a highly efficient and flexible radar system component that enhances performance by allowing the radar to transmit and receive complex, instantaneous wideband waveforms. Instead of down-converting radio-frequency signals as in conventional radar processors, the S2RSP modulates a laser with these signals. The laser-modulated signals are "written" holographically into an S2 crystal. The information stored in the crystal is then read out and reprocessed digitally, leading to range and Doppler graphics.

S2's processor provides many distinct advantages over legacy systems. The system allows for analog processing as well as wide and sustaining bandwidth capabilities up to 20 gigahertz with long time apertures. Such capabilities can provide an order-of-magnitude improvement in the bandwidth and aperture allowed by conventional systems. Analog

continued on page 2

Crystal-clear Imaging from page 1

radar-signal processing allows the user to avoid being confined to one waveform class. S2 has successfully demonstrated its technology with various waveform patterns—including random noise.

The S2RSP also has the advantage of being easy to integrate into existing radar systems. It is a technology that could either replace a receiver or operate side by side with existing units. "The modification really is as simple as taking the raw signals at the antenna and piping them over to the [S2RSP]," said S2 President Dr. Kris Merkel. For missile defense, one of the S2RSP's strategic advantages over legacy processors is the ability to provide a surveillance mode simultaneous with a fire-control mode. Two warheads could be separated by kilometers, both perhaps several thousand kilometers from the imaging radar, but each would be visible to the S2RSP simultaneously. With its Phase III contract, S2 hopes to provide the U.S. military with equipment that offers a large surveillance zone and constant wideband reception.

S2 seeks interest from other U.S. Government agencies that use passive-receive systems for surveillance, including signal-intelligence activities. The company also envisions commercializing some of the technology used in the S2RSP for short-range imaging applications needed in homeland security operations.

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