

RF Wireless Phase Shifters

...economical phase shifters

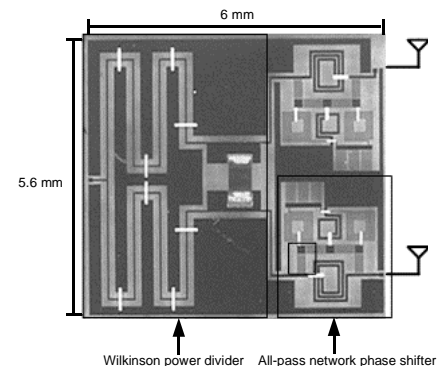
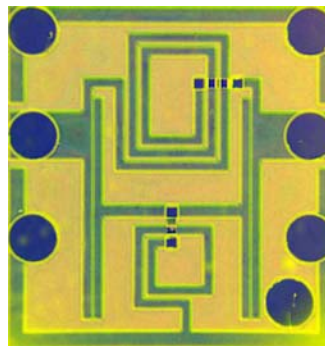
Phase Shifters

A phase shifter is an essential element in applications such as phase modulators, frequency up-converters, testing instruments, and phased array antennas. Traditionally, phase shifters have not been used in consumer applications because of the high cost of current technology. *nGimat's* phase shifters offer compelling performance at a low cost.

***nGimat's* phase shifters begin with its CCVD coating process,* an economical route to depositing the high dielectric constant material barium strontium titanate (BST) as a dense, high-quality thin film.**

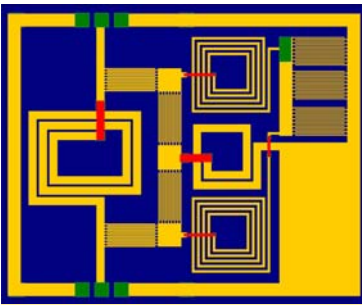
Antenna Example

Most antennas send or receive in all directions, but phase shifters enable phased array or beam steering antennas. By incorporating a network of phase shifters, a phased array antenna can be pointed electronically in microseconds, without any physical realignment or movement of the antenna or its elements. Beam steering improves the carrier-to-interference ratio of the received signal by attenuating unwanted sources of interference. *nGimat* has achieved state-of-the-art results on phase shifters to enable beam steering. Currently, phase shifters have been limited to use in military and sophisticated commercial applications due to their high cost. *nGimat* believes its ability to deposit nanolayered BST thin films will enable the development of phase shifters for consumer applications that will be commercially priced significantly lower than existing products.



nGimat has designed and fabricated an S-band phase shifter; the layout is pictured at left above. The typical die size is $\sim 4 \text{ mm}^2$. A complete beamforming network consisting of a power splitter and two phase shifters has been constructed at the Georgia Institute of Technology to test the functionality of the device in the field. A photograph of the fabricated device is shown at right above. The Wilkinson splitter is the structure on the left side of the photograph while the right hand side includes two phase shifters for a simple beam forming network. The overall size is only $6 \times 5.6 \text{ mm}$ and can be reduced below $4 \times 4 \text{ mm}$. Related performance data is provided on the back of this sheet.

*Please visit us at www.ngimat.com or call us to find out more about *nGimat's* proprietary Combustion Chemical Vapor Deposition (CCVD) process or its platform NanoSpraySM Combustion Processing technology.



Products

nGimat's current phase shifter product line includes seven models, which cover the center frequencies in the L-, S-, and C-bands.

Please visit our website at

www.ngimat.com

for more information or contact us for a Product Data Sheet.

Potential Applications:

- broadband applications • WLAN
- satellite communications
- phased array radar
- smart antennas
- circuit and power matching

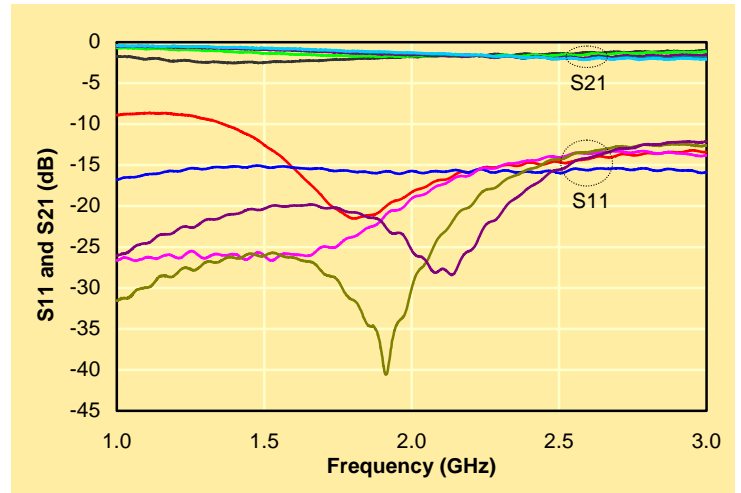
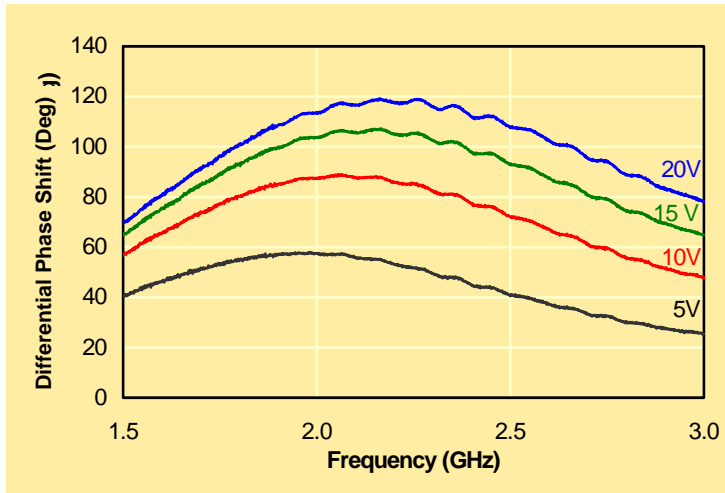
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Phase Shifters

Performance data for the S-band phase shifter pictured on the front of this sheet are presented below. At left is differential phase shifter data with respect to the phase at 0 V. At right is insertion loss and return loss data. 100° phase shift is achieved in the frequency range of 1.8-2.6 GHz.

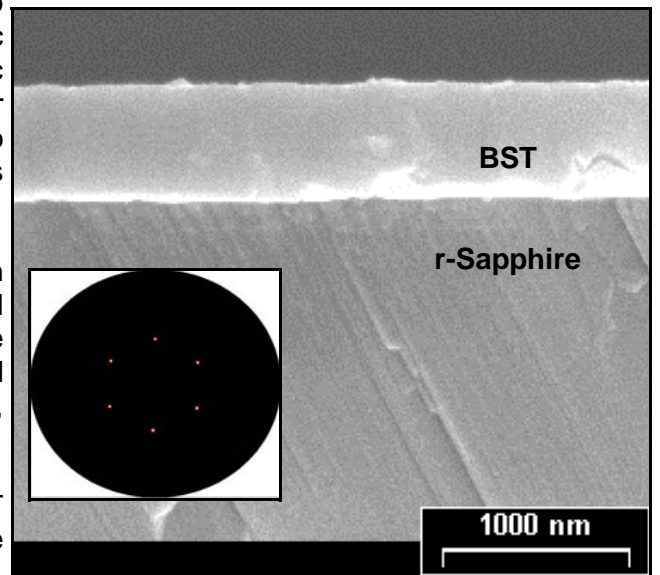


BST at *nGimat*

Historically, complex oxides in the RF/microwave domain, such as BST, have not been applied to commercial products due to the difficulty in producing high-quality thin films. *nGimat* has developed its proprietary CCVD coating process for depositing epitaxial BST dielectric coatings on sapphire that provide the building blocks for a host of microwave and RF broadband devices. BST is a complex dielectric oxide material comprised of three different cation elements and is valuable because of its ability to hold a large amount of electrical charge due to its high dielectric constant. BST has the unique ability to change its dielectric constant with an applied DC voltage, a significant benefit over existing dielectrics such as silicon dioxide. *nGimat* has also developed thin film structures and engineered nanomaterials that enable control voltages of less than 10v.

nGimat's use of BST enables frequency-agile devices with superior electrical performance with regard to loss, noise, and tunability. *nGimat*'s significant advantage is the fact that the CCVD process can deposit BST thin films at lower costs and with better material properties, due to additional nanolayers, compared to other manufacturing processes.

At right is an SEM micrograph of a cross section of a CCVD BST thin film as well as a corresponding x-ray diffraction pole figure showing epitaxy between the coating and r-sapphire substrate.



The Company. *nGimat*, located inside the perimeter of Atlanta, is an intellectual property and manufacturing company that engineers nanopowders, thin films, and devices. Our facilities are equipped with instrumentation to perform cutting edge materials research, development, and manufacturing. The scientists and engineers at *nGimat* bring backgrounds in materials science, chemistry, physics, mechanical/chemical/electrical engineering, and biochemistry to the challenges of engineering nanomaterials. In addition, our analytical personnel provide rapid turn-around times and state-of-the-art materials analysis to support our materials development.

We at *nGimat* Co. welcome your inquiries concerning our RF Wireless technology.

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