

# RF Wireless Tunable Filters

## ...tuning to multiple frequency bands

### The BST Advantage

Ferroelectric tunable filters have been envisioned but never commercially developed. *nGimat's* nanolayered barium strontium titanate (BST) dielectric coatings (see back of this sheet) will enable frequency-agile filters for consumer wireless products. *Gimat's* tunable filters are being developed to allow wireless products to be tuned to multiple frequency bands using a single DC control voltage. For cellular applications, the use of frequency-agile filters will result in 30 - 40% lower transmitter power, longer battery life, reduced handset size, weight and cost as well as the ability to operate in multiple frequency bands with a single device.

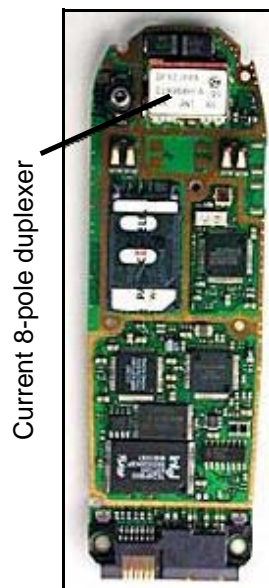
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## Applications

CDMA Cellular  
Phones

GSM Handsets

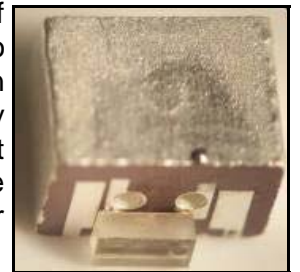
### CDMA Duplexers



Current 8-pole duplexer

A duplexer (a transmit and receive filter combined into one device) allows CDMA cellular phones to transmit and receive signals simultaneously. Current duplexers operate at a fixed frequency and vary in size depending on center frequency, bandwidth, and insertion loss. Cellular phones designed to operate at multiple frequencies require multiple filters of varying sizes. *nGimat's* tunable duplexer allows the filter center frequency to be changed simply by applying a DC control voltage, eliminating the need for multiple filters and enabling smaller filters which reduce handset weight and battery usage. *nGimat* will offer a CDMA duplexer that will be at least four times smaller (pictured at lower right), weigh less and will replace fixed frequency duplexers currently used in cell phones (shown at left). The smaller size, lower insertion loss (<2dB), and electronic tuning capability of *nGimat's* tunable filter will result in up to 40% less battery consumption than existing alternatives. This lower battery

consumption will enable increased talk time or allow handset manufacturers to further shrink the size of the battery while maintaining the same talk time. *nGimat's* initial duplexer product operates in the U.S. PCS cellular band at 1.9GHz.



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GSM Multiband Filters

*n*Gimat will also offer frequency-agile multiband filters for use in GSM handsets. Existing GSM handsets operate on up to three different frequency bands, with a fourth band (US cellular at 800MHz) being desired: 800MHz U.S., 900MHz Europe, 1800MHz Europe, and 1900MHz U.S. Each of these frequency bands requires a SAW filter and a dedicated receiver. This results in a very complex handset architecture with a high parts count and high cost.

*n*Gimat's tunable filter technology will permit a single filter to operate in both the 800MHz and 900MHz bands, with the handset dynamically tuning the filter to the correct frequency. A second tunable filter will handle the 1800 and 1900MHz bands. This allows a quad band handset to be constructed with the same complexity as today's dual band handset.

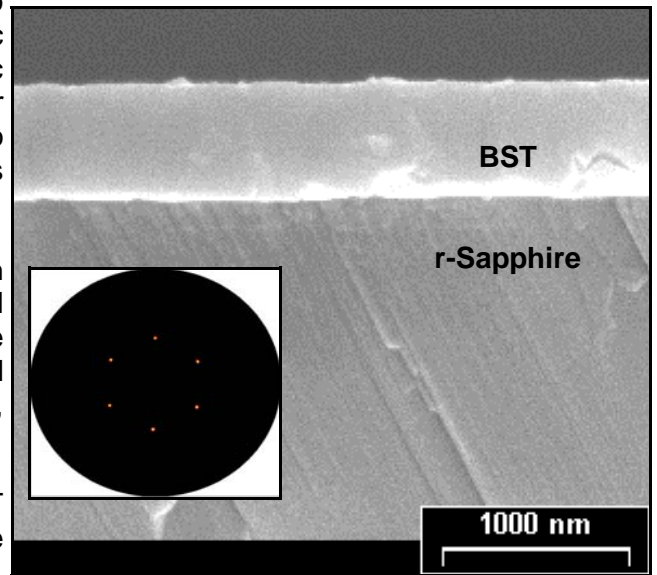
For cellular handset manufacturers, this will be a significant improvement. A single hardware platform will work anywhere in the world, independent of frequency allocations. A universal quad band handset would remove the geographic restriction without adding cost to the handset.

BST at *n*Gimat

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. *n*Gimat 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. *n*Gimat has also developed thin film structures and engineered nanomaterials that enable control voltages of less than 10v.

*n*Gimat's use of BST enables frequency-agile devices with superior electrical performance with regard to loss, noise, and tunability. *n*Gimat'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.



\*Please visit us at [www.ngimat.com](http://www.ngimat.com) or call us to find out more about *n*Gimat's proprietary Combustion Chemical Vapor Deposition (CCVD) process or its platform NanoSpray<sup>SM</sup> Combustion Processing technology.

**The Company.** *n*Gimat, 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 *n*Gimat 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 *n*Gimat Co. welcome your inquiries concerning our RF Wireless technology.**

Please visit our website at [www.ngimat.com](http://www.ngimat.com) or contact Dr. Zhiyong Zhao:

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