

# *Department of Energy Programs at nGimat LLC*

*Ganesh Venugopal*

*nGimat LLC, Lexington, Kentucky, USA*

[www.ngimatllc.com](http://www.ngimatllc.com)

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# nGimat: Company Overview



## History:

Parent company (nGimat Co.) founded on technology licensed from Georgia Tech & incubated at GT-ATDC

Successfully exited venture capital phase

nGimat LLC formed in 2010 to focus on nanopowders business



## Mission:

To provide innovative materials science solutions for current and emerging applications by supplying high-performance, cost-effective nanomaterials

## Markets:

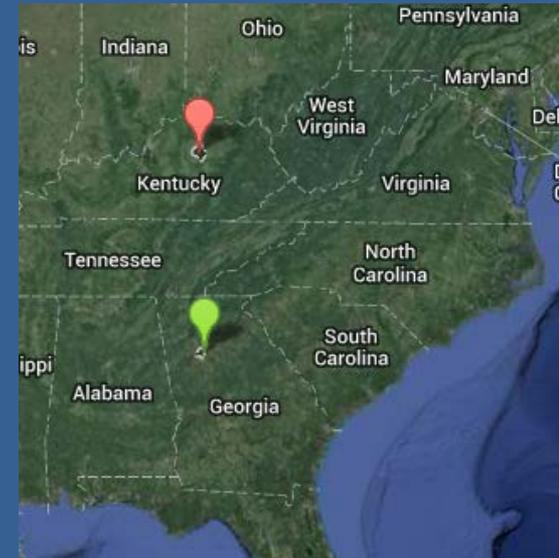
Primary markets: Energy & Automotive

Other markets: Food & beverage, Electronics, Biomedical

## Business Units:

nGimat Co.: Corporate headquarters – Thin films business unit

nGimat LLC: Wholly owned subsidiary – Nanopowders business unit



## Core technology:

Nanopowder production via combustion chemical vapor condensation (CCVC) using proprietary **NanoSpray Combustion<sup>(SM)</sup>** process

## Applications:

Wire insulation nanocomposites, Superconductor powders, Li-ion batteries, Electronic inks, Biomedical materials

## Staff:

11 Associates (PhD, Masters, Bachelors level)

Administrative, Operations help from nGimat Co.

Contractor help for some functions

## Facility & Resources:

10,000 sq. ft. facility – office, analytical lab, production area

Production area: 6 nanopowder production units, 2 wire-coaters

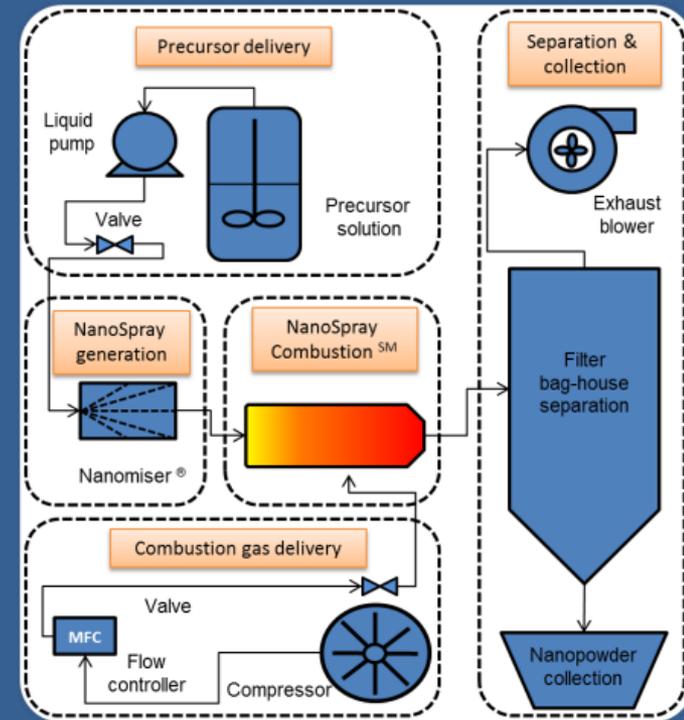
Analytical lab: XRD, BET, XRF, Wire testing, Battery testing

## Distribution partner:

**SIGMA-ALDRICH**



- *Solution combustion process akin to gas-phase combustion – scalable & cost-effective*
- *Primary compositions: Metal(loid) oxides, Multi-metal Oxides, Polyionic compounds, Noble metals*
- *Precursors: Commercially-viable metal or metalloid compounds in organic solvents*
- *Process control parameters*
  - *Precursor solution composition*
  - *Precursor solution flow-rate*
  - *Nanomiser<sup>®</sup> setting – spray parameters*
  - *Combustion gas flow-rate*
  - *Redox atmosphere*



Generalized process flow diagram for NanoSpray Combustion<sup>(SM)</sup> nanopowder production process

# DOE Funded Projects at nGimat - Overview



| Project  | Program  | Status                      |
|--|--|-----------------------------|
| <i>High-power Lithium Titanium Oxide Nanopowders for Lithium-ion batteries</i> | <i>SBIR<br/>Office of Science - EERE</i>                             | <i>Completed –<br/>2012</i> |
| <i>Scale-up of Nanopowder Production</i>                                       | <i>ARRA-SBIR<br/>Office of Science - Manufacturing</i>               | <i>Completed -<br/>2013</i> |
| <i>Nanocomposite insulation for superconducting wire</i>                       | <i>STTR (with NCSU)<br/>Office of Science - HEP</i>                  | <i>Completed -<br/>2013</i> |
| <i>High-temperature superconducting nanopowder based on Bi2212</i>             | <i>SBIR Fast Track<br/>Office of Science - HEP</i>                   | <i>Ongoing</i>              |
| <i>Nanocomposite insulation for EV motor wire</i>                              | <i>SBIR<br/>Office of Science - EERE</i>                             | <i>Ongoing</i>              |
| <i>Scale-up of Graphene materials</i>  | <i>ARPA-E (at nGimat Co) with<br/>Georgia Tech (lead) &amp; ORNL</i> | <i>Ongoing</i>              |

*Matching Funds:*

*KSTC – Commonwealth of KY*

*Commercialization Assistance:*

*Dawnbreaker (DOE)*

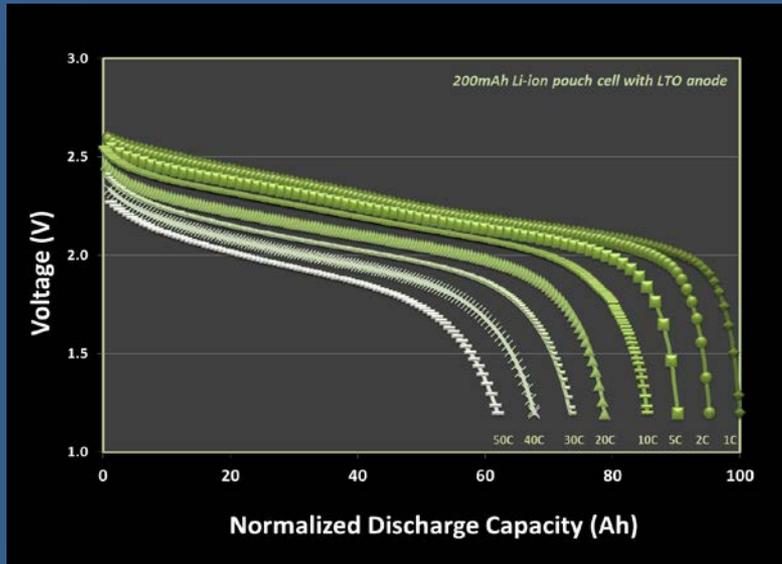
## Demonstrated:

“One step” synthesis of LTO nanopowder

Fast charge and discharge rates

Extended cycle life operation

>10kg/day production rates



Fast discharge up to 50C (1.2 minute discharge)  
>60% discharge capacity

## Partners:

Quallion LLC

## Commercialization efforts:

R&D Sales via Sigma Aldrich – to battery & supercapacitor customers

Exploring niche military applications for batteries & hybrid-super-capacitors

Potential mainstream applications in micro-hybrid automotives

## Challenges:

Meeting pricing expectations for mainstream applications

Managing the energy density tradeoff that accompanies power density gains

## **Demonstrated:**

*“Bottom-up” process*

*>100kg/day production rates*

*Transition to low-cost precursors & bio-derived solvents*



*Large powder collection bag-house used for >100kg/day production rate project*

## **Partners:**

*Georgia Institute of Technology*

## **Commercialization efforts:**

*System being utilized for producing nanopowder sorbents – for desulfurization in natural gas sensors*

*Other production opportunities being considered – including Bi<sub>2</sub>2<sub>12</sub> HTSC production for ongoing DOE project*

## **Challenges:**

*Managing change-over costs for low-volume high mix nanopowder production*

*Identifying opportunities where system can be utilized continuously*

## Demonstrated:

All ceramic insulation with high thermal conductivity and compact form-factor

Enhanced quench propagation characteristics (NCSU)

Insulation of Bi2212-wire insert coil for 34T magnet (FSU)

## Partners:

North Carolina State University

## Commercialization efforts:

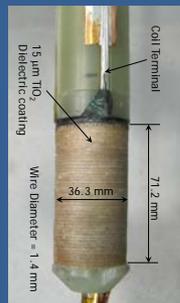
Toll coating service to High-energy Physics (HEP) community - ongoing

Potential future opportunities in NMR and MRI magnets - TBD

## Challenges:

Developing a sustainable business model for working with HEP customers

Time-frame for transitioning from HEP to NMR/MRI applications



Insert for 34T Magnet  
-Built by FSU with  
-nGimat coating

## Ongoing project:

Successfully demonstrated Bi2212 production using NanoSpray Combustion

Comparable performance to competitor in powder and wire testing trials

Performance enhancement, scale-up and wire –drawing trials underway (Phase II)

## Partners:

North Carolina State University, Supramagnetics

## Commercialization potential:

Powder supplier to HTSC manufacturers for HEP projects

Potential future opportunities in NMR and MRI magnets - TBD

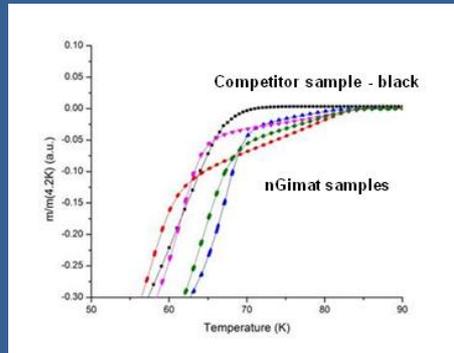
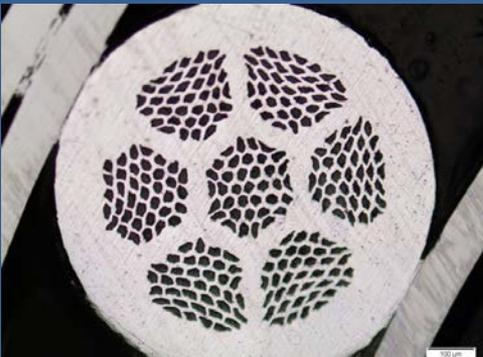
$\text{Bi}_2\text{Sr}_2\text{Ca}_1\text{Cu}_2\text{O}_{8+\delta}$   
(Bi2212, BiSCCO)  
Wire

$\text{Bi}_2\text{Sr}_2\text{Ca}_1\text{Cu}_2\text{O}_{8+\delta}$   
(Bi2212, BiSCCO)  
HTSC Performance

## Challenges:

Developing a sustainable business model for working with HEP customers

Time-frame for transitioning NMR/MRI from LTSC to HTSC



## Ongoing Project:

*Developed EV motor magnet-wire insulation with 10X thermal conductivity vs. conventional insulation*

*Optimization of thermal conductivity vs. breakdown strength etc. underway*

*Optimized insulation to be tested in prototype motors to demonstrate performance enhancement*

## Partners:

*National Renewable Energy Labs,  
Oakridge National Labs*

## Commercialization potential:

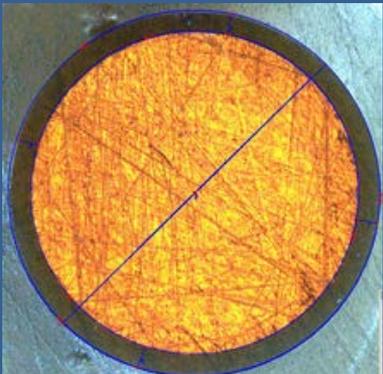
*Potential supplier of nanocomposite coating formulations to copper wire manufacturers*

*Potential future opportunities in aerospace, military sectors - TBD*

## Challenges:

*Developing a low-cost materials technology acceptable for automotive applications*

*Interfacing effectively with wire-manufacturers and car-makers*



## Ongoing Project:

*Adapt NanoSpray Combustion process technology for scalable, continuous production of Graphene*

*Work with partners to demonstrate materials in supercapacitor devices*

*Explore commercialization potential in energy and other applications*

## Partners:

*Georgia Tech (lead), Oakridge National Labs*

## Commercialization potential:

*Higher energy storage alternatives to conventional electrochemical supercaps*

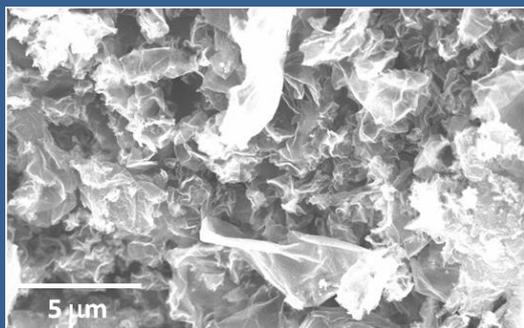
*Potential future opportunities in printed electronics – TBD*

*Early sales to R&D community*

## Challenges:

*Finding the killer-app for graphene*

*Demonstrating a cost-effective process compared to competition*



*nGimat LLC has secured five Phase II awards and has partnered as collaborator on one ARPA-E effort*

*Early commercialization efforts are underway on three completed projects*

- *Nanopowder sorbents for desulfurization applications currently used in commercial natural gas sensors*
- *Toll-coating services of HTSC wire-coating for HEP community*
- *Several nanopowders marketed for R&D applications via Sigma Aldrich – higher volume applications being explored*

*Work ongoing in three other projects*

*Kentucky state match funds have been key for supplementing DOE efforts*

## *Acknowledgements*

