

Executive Summary



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1. Title of the Project: Beyond AlGaIn-GaN High Electron Mobility Transistors for power and RF electronics: **ScAlN** technology development for RF filters and nitride electronics.

2. Date of Start of the Project: October 1, 2020

3. Aims and Objectives:

Year 1 Milestone from project proposal: Reactor set up for accepting the new bubbler (its typically a 6 month shipping time for Metal Organics) and preliminary runs.

Year 2: ScAlN HEMT wafers on Si

Year 3: 100 micron gate width power transistors.

Year 4: Optimized material for power applications and 5 mm gate width power transistors.

Year 5: 500 nm gate length RF devices

4. Significant achievements (not more than 500 words to include List of patents, publications, prototype, deployment etc):

Post design that took into account the constraints of integrating a new source with a working semi-production scale MOCVD reactor, the Sc source has been integrated with the said reactor. Growth is being optimized. ScAlN-GaN HEMT wafers and devices are expected to be realized in the current calendar year as a result of this effort. A device process flow that is currently available for realizing HEMTs on AlGaIn-GaN wafers will then be implemented on these layers so realized to enable the first MOCVD ScAlN HEMT from India and among the first in the world.

Key papers published by the fellow in the last year include:

- I. [Mechanistic insights into supersaturation mediated large area growth of hexagonal boron nitride for graphene electronics](#), A Rao, S Raghavan, Journal of Materials Chemistry C 10 (28), 10412-10423, 2022
- II. [Molybdenum and Tungsten Di-sulfides: First Principles Investigation of Adatom Attachment and Diffusion on c-plane Alpha Sapphire and Correlation with Growth](#), A Lalithambika, VK Kumar, M Jain, S Raghavan, Crystal Growth & Design 22 (8), 4708-4720, 2022
- III. [Monolithic Epitaxial Integration of \$\beta\$ -Ga₂O₃ with 100 Si for Deep Ultraviolet Photodetectors](#), S Vura, UU Muazzam, V Kumar, SC Vanjari, R Muralidharan, N Digbijoy and Srinivasan Raghavan, ACS Applied Electronic Materials 4 (4), 1619-1625, 2022

5. Concluding remarks

I gratefully acknowledge the financial assistance provided by the INAE through the Abdul Kalam Fellowship, which has supported the nucleation of a new material based technology area in the country. While progress was impacted by the pandemic, I believe the first ScAlN films from India by MOCVD and among the first in the world would be realized in this year.