九州大学

講演会のご案内

日時：　2018年1月31日（水）14時～17時
場所：　九州大学応用力学研究所６階　W601室

【講演１】
Advances in nitride film and coating growth by chemical vapor deposition
By Dr.Michel Pons (SIMAP/CNRS)

【講演２】

A global modeling methodology for selection and design of advanced materials in communication and energy
By Dr.Frédéric Mercier (SIMAP/CNRS)

【講演３】

Next generation of power semiconductor device technologies for energy sustainable society
- My perspective
By Prof Shankar Ekkanath Madathil (Sheffield University)

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Advances in nitride film and coating growth by chemical vapor deposition

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Modification of surface properties by depositing ceramic thin films on substrates is a common technology to improve the performance of tools and components for many different industrial applications, such as photo-catalysis, optical coatings, sensors, integrated optics, metal-cutting industry, or microelectronic devices. There are various techniques to prepare nitride thin films and coatings such as sol-gel method, physical vapor deposition (PVD) and chemical vapor deposition (CVD). Among these techniques, CVD is an advanced manufacturing and straightforward technique for the depositing homogeneous films with a good step coverage even on complex shapes. In addition, CVD methods can produce single layer, multilayer, composite, nanostructured and functionally graded coating materials with well controlled dimension and unique structures in a short time. Assisted or Enhanced CVD techniques by plasma, laser or hot wire allow lower temperature deposition (<500 °C) than those required by standard chemical vapor deposition (>800 °C for nitrides). In the same way, thin films can be deposited by metal-organic chemical vapor deposition (MOCVD) on substrates requiring low temperature processing. When only tens of nanometers films and very low temperature (<300 °C) are required, Atomic Layer Deposition (ALD and Plasma ALD) is a technique of choice for medical and textile applications.

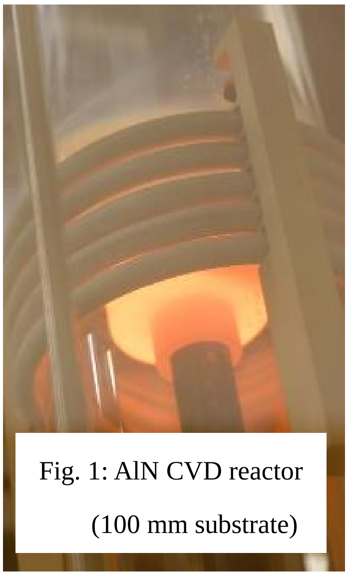

Fig. 1: AlN CVD reactor (100 mm substrate)

In the present talk, firstly, the different CVD methods, their advantages and drawbacks and the market served are reviewed and discussed. Secondly, a special focus will be made on the different applications of AlN thin films and coatings processed at high temperature and the ways to tailor their function (deep UV, piezoelectric, HT barrier …) with operating parameters (Fig. 1) and microstructure (Fig.2). At last, the review will present advanced materials and potential applications.

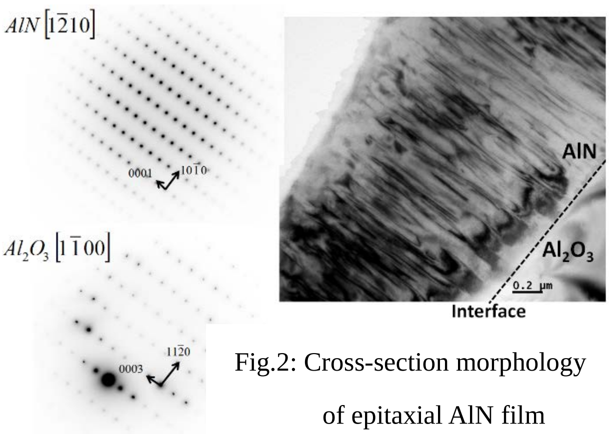

Fig.2: Cross-section morphology of epitaxial AlN film

A global modeling methodology for selection and design of advanced materials in communication and energy

Frédéric Mercier, SIMAP lab., CNRS, Université Grenoble Alpes

The purpose of this talk is to present a global modeling methodology to select and design advanced materials for communication and energy. The presentation will be focused on the high temperature chemical vapor deposition technique called also HVPE (Hydride Vapor Phase Epitaxy). The methodology involves (i) a “material by design” approach to select the best material for the given application, (ii) a thermodynamic modeling to analyze chemical reactions during the synthesis of the material, (iii) multicomponent heat and mass transport coupled with level set methods to have access to relevant local parameters like supersaturation and to represent the interface evolution and (iv) a mechanical modeling to analyze the different source of stress during growth. The global modeling methodology will be illustrated with three successful examples recently obtained at SIMAP lab.:

- Epitaxial layers of AlN for advanced SAW (Surface Acoustic Wave) devices
- Ultrathin films of NbN for single photon detectors
- Multilayer coatings based on SiC and AlN for concentrated solar power technologies

Next generation of power semiconductor device technologies for energy sustainable society - My perspective

Power Semiconductor devices are key to energy efficiency and to realise sustainable carbon footprint. This talk will cover essential basics and address key technological advances being made in Silicon and Gallium Nitride. From a performance over cost as well as reliability perspective, silicon based power devices will continue to play a crucial role in current and future power electronics systems. There is significant potential for performance gains in IGBTs using fine lithography and 3-D scaling rule. In this talk, the implications of 3-D scaling in a MOS controlled thyristor device, known as the Clustered IGBT is highlighted.

Transition from the conventional scheme of manufacturing circuits using discrete components to that of a fully integrated power system-on-chip is anticipated to be a prerequisite to take advantage of the high-frequency power switching benefits offered by GaN devices. High slew rates, in the presence of parasitic inductance (device/package/circuit) can result in over-voltage transients, which can seriously impair the functionality of a GaN device. Even with the most innovative packaging approaches, a finite residual inductance is present. Monolithic integration of gate drive circuitry with power devices on a single technology platform is considered as an essential approach to minimize parasitic inductance in the circuitry and therefore enable stable high-frequency operation, efficiency and power densities unachievable by existing techniques. The fundamental requirement of a semiconductor technology platform that enables simultaneous development of a wide range of high voltage and low voltage N and PMOS devices as required for integration is served by the Polarisation Super Junction (PSJ) platform in GaN. This technology is briefly described in the talk.

Prof Shankar Ekkanath Madathil @ EM Sankara Narayanan was a Royal Society Industry Fellow in Rolls-Royce between 2013 and 2017 where he worked on the systems impact of next generation power electronics technologies; prior to that he was a Royal Academy of Engineering Chair in Power Electronics from 2007-2013. His team has proven world leading design-2-manufacture expertise in Silicon and GaN. He is an editor of IEEE – TDMR, IEEE-TED, and Proceedings of the Royal Society A and an associated editor of IET – PEL and holds 40 patents/applications and published more than 250 articles.