PROCORE - FRANCE/HONG KONG JOINT RESEARCH SCHEME COMPLETION REPORT

Project Reference Number

F-HK03/10T (CityU Ref No: 9052003)

Project Title

Terahertz measurements of ballistic electron motion and plasma waves resonances in singlewalled carbon nanotubes

Particulars

	Hong Kong team	French team
Name of Project Co-ordinator (with title)	English: Chan Yan Cheong Chinese: 陳忍昌	Torres Jeremie
Name of Co-Investigator (if any)	English: Chinese:	Varani Luca
Institution or Institutional affiliation	x CityU; HKU CUHK; HKUST HKBU; LU HKIEd; PolyU	CEA; INRA CNRS No.; INRIA INFREMER; INSERM No. * University of Montpellier 2 Others:
Other project team members (if any)		

Funding Period

	1st year	2nd year (if applicable)
Start Date	01/01/2011	01/01/2012
Completion Date	31/12/2011	31/12/2012

Objective(s) as per original application

1. Design, fabricate, study the reliability, characterize and model the THz devices based on SWNTs devices suitable for the excitation of plasma waves and ballistic electron motion resonance.

[Please attach relevant document(s)]

i) Outline of proposed research and results obtained

High electron mobility devices are used to promote the nature of ballistic transport of electrons thus increasing the oscillation phenomena of plasma resonant electronic transit time or Gunn effect.
On the one hand, we have studied - using a transmission experiment spectrally resolved in the ranges 220-325 GHz and 700-1100 GHz and operating from room temperature (300K) down to the temperature of liquid helium (4K) - changes on the transparency of these samples.
Currently, a study of photo-excitation of plasma waves in similar structures is implemented and has led to the publication of a poster presentation at the conference EDISON-17 in Santa Barbara. These experiments will be continued to validate the encouraging results already achieved and continue writing a joint publication.

ii) Significance of research results

In summary, the experiments at the Montpellier University have laid the foundation for the experimental study on the transient phenomena at very high frequencies.
Arising from the preliminary research collaboration results, further samples CityU of Hong Kong will be fabricated in due course, and is expected to highlight new physical phenomena at very high frequency oscillations.

From the point of view of educative activities, we also established a framework agreement between the University of Montpellier 2 and U-City of Hong Kong to facilitate the exchange of students. A specific agreement between the Dept. of Electronic Engineering and Master EEA is under discussion to allow the term establishment of a MASTER between the two teams.

iii) Research output

The following article has been published and results for this collaboration :
L. Tohme, S. Blin, P. Nouvel, J. Torres, J. Wang, K. Tse, K. Chu, Y. Chan, C. Palermo, and L. Varani, "Long-Term Memory Effects in Photo-Excited InGaAs High-Electron-Mobility- Transistors," in Proc. 17th International Conference on Electron Dynamics in Semiconductors, Optoelectronics and Nanostructures, Santa-Barbara USA, Aug. 7-12, 2011.

iv) Potential for or impact on further research collaboration

According to the initial project, the main motivation for further research collaboration is to complete the experimental research already conducted and perform a verification of these theoretical results.

In addition, experiments at the university of Montpellier will be continued by including various electrical characterizations temporally resolved to highlight the "kink" features. These kinks are indeed a signature of very high frequency oscillations in the current-voltage characteristics of these nanostructures. Finally, using this combination of experimental results and numerical simulations, a comprehensive analysis of THz oscillations will get a thorough understanding of the physical processes involved and design a new type of ultra-fast for future electronics oscillator.

Further to this, Prof YC Chan, Prof Jeremi Torres and Prof. Christophe Gaquiere of University of Lille have applied a joint ANR/RGC Blanc programme Transnational collaboration (2013-14) research project "RELIGHT (RELIability study of Gallium Nitride (GaN) based High electron mobility Transistors (HEMTs) for advanced power electronic applications). The prime ambition of RELIGHT project is to characterize the GaN-based HEMTs with different geometries and designs on Si substrate and to formulate a relationship between their structural, the mechanical properties and their electrical performance. In addition, the reliability of GaN-based HEMTs will be evaluated under harsh service conditions, i.e. high-temperature storage testing, high drain-bias testing, high-humidity/temperature testing and vibration/mechanical shock testing - in combination with component-level and broad level packaging. The working mechanisms of GaN-based HEMTs will then be explored in order to develop a better scientific understanding of physical degradation and migration-induced failure mechanisms under combined electro-thermo-mechanical loading. This exploration of mechanisms, together with development of a theoretical model, will be the major part of the research to be carried out. As far as we are aware, the RELIGHT research will be the first study of its type - and we expect its findings to contribute to the responsible development of the global microwave power electronics industry.