Graphene and New 2D Materials: Industry Needs and Commercialization

C.Y. (Chun-Yung) Sung Ph.D
Technical Director of Advanced Technologies, Mission, Systems and Training (MST)
199 Borton Landing Road, PO Box 1027 M/S 101-125, Moorestown, NJ 08057-0927
Chief Scientist, Corporate Engineering and Technology Office (CETO)
6801 Rockledge Drive, MP 363, Bethesda, MD 20817
850-687-3624(Cell) chun-yun.sung@lmco.com; 850-687-3624

Abstract

Lockheed Martin (LM) is seeking to establish a multidisciplinary and internationally collaboration devoted to the design and development of advanced two-dimensional (2D) layered materials. The effort will synergistically integrate each LM business units with academic, research institute, government and leading national/international Industries. We will review industrial needs for defense and IT communities and define applications in key strategic areas for national interests in materials, devices and systems including but not limited to analog and digital electronics, optoelectronics, multifunctional sensors and actuators, shielding, energy storage/harvesting, anti-corrosion, oxidation, abrasion and friction. The successful collaborations between academia, governmetn and industry will yield the most valuable opportunities in nanomaterials and define transformational goals and impacts in nanotechnology industry. The outlines of talk include:

• Overview Industry Needs:	*- Defense Industry, - IT Industry, - Others*
• Review Achievements in Graphene:	*- Materials, - Devices*
• New 2D Material Developments:	*- Materials, - Applications*
• Outlook Opportunities in 2D Materials:	*- Defense, - IT and Others, examples*
• Commercialization:	*- Government, Academic, VC and Industry Roles*

2D materials exhibit a variety of unique properties different from bulk that will enhance the performance of existing technologies and enable future potentials. The outstanding characteristics also suggest that these materials could provide new possibilities in analog and digital electronics, optoelectronics, multifunctional sensors and actuators, shielding, energy storage/harvesting, anti-corrosion, oxidation, abrasion, friction, extreme environmental tolerance, biocompatibility, and transport properties, especially with ultrathin scales. However, the fundamental study of synthesis, integration, properties, processing techniques and scale-up ability of these novel material systems is in early stage and absolutely required for the success of scientific innovation and industrial foundation establishment. The developments of novel 2D materials such as graphene, MoS2, WS2, hBN, and WSxSe1-x need to leverage and ensure close academic-industrial collaborations. Furthermore, the cross-cutting expertise and wide ranging industrial partnership between the equipment manufacturers, material suppliers, semiconductor companies, small businesses and large corporations will result in a unique synergistic alliance to further exploit the unprecedented physical properties of 2D nanomaterials and revolutionize multifunctional technologies. The pursuits should have the following activities: performing transformational and application R&D, developing IPs, establishing low cost nanomanufacturing, and undertaking technology transitions.

For this effort, LM's advanced materials and nanotechnology ultimate visions include: Enable affordable and highly scalable applications in air, space, on land, at sea with multifunctional performance superior to conventional materials; Shift paradigms in multiple industries like energy, sensing, and computing as well as fundamental manufacturing; Generate materials-by-design capabilities for unmatched technological advantage in our core market, blazing major trails into multiple adjacent and horizon markets. Our clear missions are to coordinate and leverage advanced materials and nanotechnology development efforts and capabilities to capture and maintain technological leadership and drive technology transition consistent with defense priorities and key promising adjacencies that will both strengthen our leadership position and support continuing, cutting-edge research and development in this domain. The major focus areas for novel 2D materials cover Nanomaterials and Manufacturing (revolutionary multifunctional structures, enable low-cost manufacturing); Energy (cables and wiring, advanced batteries and supercapacitors); Sensors and Electronics (broad-band infrared sensors, flexible electronics); Modeling and Advanced Computations (enable bio-mimetics; computers as powerful as the brain); Adaptation and Stealth.

We will illustrate the following three approaches: Advance S&T Discovery - Enable exploration for new technology development to strengthen our ability to provide innovative and affordable solutions into our core products while supporting technology development for adjacent markets and business growth; Build Global Technology Partnerships - Create and build partnerships globally and across the company to accelerate technology integration and transition. Reduce risk and optimize our return on investment through effective scouting and key university, small business, and S&T customer relationships; Catalyze S&T Collaboration Opportunities - Focus on nanomaterial innovations through strong S&T Engagements, data analytics and information milestones to advance game changing technologies and support technology transition while sustainably growing our capability of today and tomorrow.