Short Communication
Volume 10:5, 2022

Journal of Astrophysics & Aerospace Technology

ISSN: 2329-6542

Open Access

A Concise Outline of the School of Aerospace Engineering

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Introduction

Discovery of structural superlubricity. The dream of achieving "zero" friction at solid interfaces is a long-pursued goal of scientists [1]. It was predicted in 1990 that incommensurate interfaces could host nearly zero friction, named as structural superlubrictiy, however, only at nanoscale under ultrahigh vacuum condition and at a low sliding speed. In 2012, Prof. Zheng's team reported the first observation of micrometer-scale superlubricity at ambient conditions and speeds of up to 25 m/s [2]. The discovery has been recognized as a break-through advancement by the leading experts in the field, and has attracted enormous research interests.

Description

The success of the experiment is contributed to another discovery by the team-self-retraction motion of graphite crystal where vdW interaction was revealed as the driving force. Based on this unique phenomenon, the team designed novel experimental tools to study structural superlubricity and measure the cohesive energy of the vdW media. The team was also the first to conduct mechanistic studies on the self-retraction motion driven by the vdW force [3].

The team revealed that the novel elastic buckling behaviors of vdW layered media stem from the extremely high anisotropy in elastic constants, which can reasonably explain some anomalous experimental observations reported in Science in 1997 and 1999). The team found that graphite has the highest elastic anisotropy among all hexagonal crystals, and single walled carbon nanotube bundles have even higher elastic anisotropy [4]. The team developed the first mechanical model for single walled carbon nanotubes, taking into account all elastic constants, elastic anisotropy, and size effect. A multi-beam shear model was proposed to explain the anomalous vibrational behaviors of graphene-multilayer beams MD is Molecular Dynamics, MBSM is Multibeam Shear Model, EBM is Euler-Bernoulli beam Model, f is resonant frequencies and n is layer number. And a model for strength and toughness design of vdW layered media was proposed based on their microstructures and interlayer cross-links.

Their research has greatly advanced the progress of solid mechanics and relevant interdisciplinary fields, and provides theoretical insights for the practical design of high-performance micro/nano structural materials with ultra-low friction and wear. The team members have been invited to give plenary keynote talks over 10 times [5].

Assoc. Prof. Yihui ZHANG from the SAE has made pioneering contributions to the development of a brand-new approach for assembly of complex 3D mesostructures through mechanically-guided deterministic buckling of 2D micro/nanomaterials. This approach is characterized by its applicability not only to a diversity of materials but also to a broad range of length scales. To understand the underlying relations between the 3D buckling configurations and fabrication parameters, his group developed the analytic mechanics models of post-buckling in ribbon-shaped mesostructures as the guidelines for material/geometry designs.

Conclusion

When combined with strategically designed release sequences and 2D precursors, this approach allows access to the reconfigurable 3D mesostructures that can be switched between different stable states. Their work provides a new route for fabrication of advanced 3D micro/nanodevice systems, which allows transformation of virtually any type of existing 2D microsystem technology into a 3D configuration. For example, the group has proposed novel designs to enable tunable Radio Frequency (RF) devices, concealable electromagnetic devices, highly-integrated 3D soft electronics, and self-propelled micro-robots.

Conflict of Interest

The authors declare that there is no conflict of interest associated with this manuscript.

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Received: 03 May, 2022, Manuscript No. Jaat-22-67443; **Editor Assigned:** 05 May, 2022, Pre QC No. P-67443; **Reviewed:** 17 May, 2022, QC No.Q-67443; **Revised:** 21 May, 2022, Manuscript No.R-67443; **Published:** 29 May, 2022, DOI: 10.37421/ 2329-6542.2022.10.213

How to cite this article: Li, Luis. "A Concise Outline of the School of Aerospace Engineering." *J Astrophys Aerospace Technol* 10 (2022): 213.