Nanostructured Carbon Technologies via Cold/Hot Plasmas for Energy and Media Applications

Rajdeep Singh Rawat[1]
[1] Natural Sciences and Science Education, National Institute of Education, Singapore
e-mail (speaker): rajdeep.rawat@nie.edu.sg

The versatility of nano-structured carbon makes it a key enabler in sustainable energy, data storage, healthcare, and advanced manufacturing, driving innovations across multiple high-tech sectors. This proposed plenary talk aims provide an overview of the work in synthesis of nano-structured carbon (graphene, carbon nano-walls, carbon nanotube and thin carbon protective film) using both the low-temperature low-density continuous RF plasmas and by high-temperature high-density hot pulsed plasma for wide ranges of applications. The development of new materials and modification/improvement of existing electrode materials at the atomic level are two prime strategies to increase the performance of energy storage devices. Synthesis and processing of anode electrode materials with desired structural, morphological, physical and chemical properties is achieved through low-temperature plasms strategies with improved Li/Na-ion storage with improved charge transport properties. I will present our work on using low temperature carbon plasma to process and synthesize high performance anode electrode material for Li/Na-ion batteries.

This will be followed by details on the development of a new patented platform technology using of pulse high energy density hot dense plasmas for high sp3 content sub-nm thick large area uniform carbon coating for magnetic media industry. The hard disk drive (HDD) industry has ushered into a new era with new magnetic data storage technology - Heat Assisted Magnetic Recording (HAMR), as Seagate successfully rolled out Mozaic 3+ HAMR drives with more than 3 TB per platter in the first quarter of 2024. The HAMR based HDD has an areal density of about 2 Tb/inch2, with potential to push the areal density beyond 4 Tb/inch2. One of the main challenges to do so is the deposition of carbon overcoat (COC) with key parameters: thickness of ~1 nm, high sp3 content (>30%), particle-free (<5 particles), high thickness uniformity and without pinholes. The key technologies currently used for COC deposition, however, are unable to do so. For this purpose, we specifically developed a large-volume-slow-focus-mode dense plasma focus (LVSFM-DPF) device, by deliberately designing the DPF with large external inductance to slow down its pinch phase, to achieve heat assisted magnetic media (HAMR) relevant ~1-1.2 nm thick, large area (65 mm diameter), highly uniform COC with >50% sp3 content in a single sub-second duration DPF shot. Key results will be highlighted.

References

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