



## **Department of Materials Science and Engineering Seminar Series 2025**

### **Synthesis of monolayer amorphous carbon and its application**

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**Date and time: 2026-April-10, 10:00AM**

**Venue: EA-02-15**

#### **Abstract**

Monolayer amorphous carbon (MAC) has emerged as an intriguing two-dimensional (2D) material, attracting attention for its unique properties and potential applications. Similar to graphene, MAC consists entirely of  $sp^2$  hybridized carbon atoms arranged in a disordered, non-regular pattern. The lack of long-range order results in a variety of carbon rings, including five-, seven-, eight-, and nine-membered rings, alongside the common six-membered hexagons seen in graphene. Over the past few years, its properties have been extensively studied, revealing high mechanical strength, excellent ion impermeability, chemical inertness, and superior electrical insulation. However, the interaction mechanisms between MAC and other surfaces remained largely unexplored.

In the first part of this work, the interaction between MAC and its as-grown copper (Cu) substrate was investigated. Beginning with the measurement of adhesion energy at the MAC/Cu interface via a standard peeling test, the results show that MAC adheres to Cu approximately 13 times more strongly than graphene. Surprisingly, Kelvin Probe Force Microscopy (KPFM) shows weaker electric forces at the MAC/Cu interface compared to graphene/Cu. A detailed investigation via X-ray Photoelectron Spectroscopy (XPS) and Near-Edge X-ray Absorption Fine Structure (NEXAFS) spectroscopy reveals the formation of

covalent-like Cu-C bonds at the MAC/Cu interface, which contributes to the enhanced adhesion.

MAC's ultra-strong adhesion elevates its potential as an ultra-thin barrier film, which is essential for applications requiring robust surface protection, notably hard disk drives (HDDs). Replacing HDD's current 2.7 nm carbon overcoat (COC) with a 0.8 nm-thick MAC layer has the potential to increase areal storage density by 10 times. The second part of this work focused on manufacturing-compatible, direct low-temperature MAC grown on HDD magnetic surfaces. Successful MAC growth on HDDs was verified via cross-sectional transmission electron microscopy (TEM), followed by corrosion, thermal stability, and mechanical tests, that validated its performance, confirming MAC's suitability for next-generation HDD COC.

In summary, this work reveals how MAC strongly adheres to Cu substrates and demonstrates its practical use in advanced devices like HDDs, highlighting MAC's importance in real-world technology.

## **Biography**

Hongji Zhang is currently a Ph.D. candidate at the MSE department under the supervision of Prof. Barbaros Oezylmaz. His research focuses on the synthesis of monolayer amorphous carbon and its usage for industrial applications.

**Please join us!**

HOST: Asst Prof Zhong Peichen