

5. A long roadmap for 2D materials

- a) The most promising method for growing graphene for electronic applications is CVD (Chemical Vapor Deposition). The main advantage of CVD is that the quality of the resulting graphene is usually very high (high mobility). The current state of the art of this method is that it produces crystallites sizes of 50,000 μm at a sample size of 1000 mm. It is used to serve applications such as photonics, nanoelectronics, TCs, sensors, bio-applications, flexible electronics.
- b) Excluding graphene, phosphorene offers the highest RT mobility ($\mu \sim 286 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$). It has a bandgap of 0.9 eV.
- c) Excluding graphene, MoS_2 offers the highest bandgap (1.8eV). It has a RT mobility of $\sim 60\text{-}70 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$.

d) Optoelectronics and photonics:

Advantages:

- + High μ enables ultra-fast conversion of photons or plasmons to electrical currents or voltages.
- + Graphene photonic devices can be fabricated using standard semiconductor technology.

Challenges:

- Current polarization controlling devices are bulky and/or difficult to integrate for photonics.
- For photo-detectors, we will need to increase responsivity, which might require a new structure, plasmonics and/or doping control.

e) Health & Environment:

Advantages:

- + It will offer the possibility to introduce more information on goods used on a daily basis, e.g. on food for safety and health, as well as on many other products.
- + Current research in nano-biosensors is experiencing a fast growth due to the wide range of novel applications for human healthcare.

Challenges:

- The GRM small size and unique physico-chemical properties may pose potential health and environment risks.
- Some GRMs have aerodynamic size that may lead to inhalation and deposition into the respiratory apparatus with implications on the formation of granulomas and lung fibrosis.