Graphene & related Aeromaterial Devices by chemistry only

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Assembly of actuators, sensors, or energy devices typically involves complex structuring methods based on lithographic microstructuring processes or electromechanical assembly. In this talk, a class of ultralightweight and open porous materials known as aeromaterials will be reviewed, that can fulfill these functions without any of those microstructuring techniques. These materials can be created through wet or gas phase chemistry and directed self-assembly steps using 2D materials like graphene variants, TMDC's, h-BN, or MXCENE. This allows them to be shaped and assembled into 3D aeromaterials either by a gas phase process or from wet chemical inks that can be used directly as functional devices, such as a pneumatic actuator [1] capable of lifting more than 10,000 times its own weight (see figure 1).
To achieve the desired shape with the right porosity and enhanced surface area, a template process based on a flame transport synthesis is used. This process enables the massive growth of tetrapodal shaped ZnO microcrystals, which can be arranged in a 3-dimensional, continuously connected network spanning macroscopic dimensions. The gas phase process has already been demonstrated with the Aerographite process, which was introduced 11 years ago [2]. In this process, thin 2D layers are formed, and the ZnO network [3] is simultaneously decomposed. The CVD can be used to form 2D materials, such as graphene layers, surprisingly directly on the surface of the ZnO. A variant based on ammonia found by Schütt [4] can even synthesize h-BN layers on the ZnO, creating a strong light-scattering material. Nanoscale GaN [5] is capable of growing even epitaxially on the ZnO. In the wet chemical infiltration procedure, basically every 2D material ink can be utilized, including variants such as carbon nanotubes [6].
Finally, examples of fully functional devices made from these 2D materials will be presented and discussed.

References

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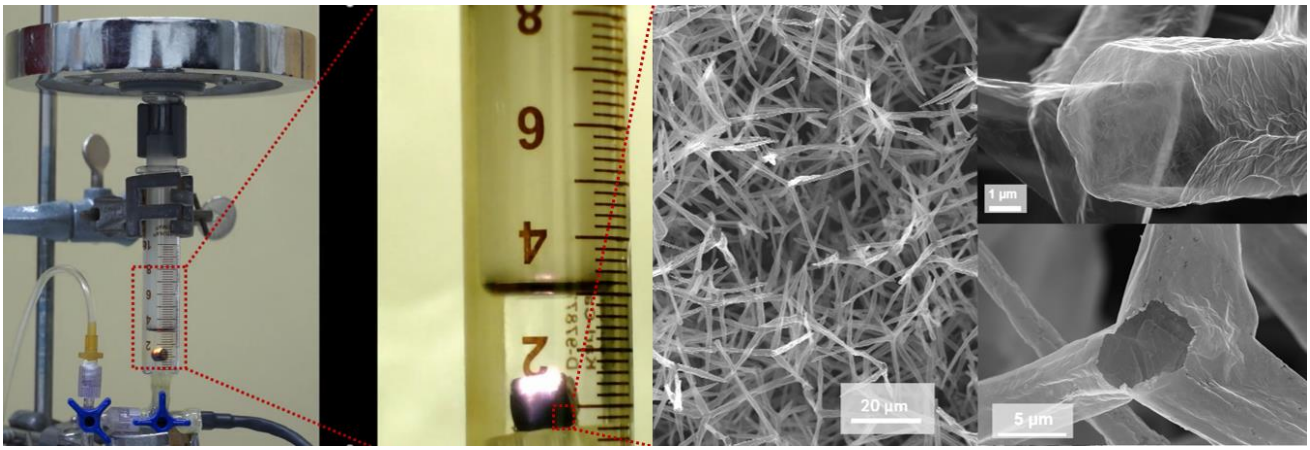

Figure 1: Graphene based pneumatic actuator of ~1mg lifting 2 kg and magnification into its microstructure