

A new perspective on graphene based flow sensors

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Graphene with its extraordinary electrical, chemical and mechanical properties is a very promising material for different kind of sensors. Liquid flow meters are among many possible applications, which could gain importance in industrial and medical applications. Besides the possibility to measure the liquid flow, energy harvesting from a moving ionic liquid across the graphene surface was reported [2]. This promising subject is currently being widely investigated, yet the origin of the signals generated in graphene by liquid flow is still not well understood and is a subject of strong controversy.[1][2][3].

In this communication, we present new results on graphene based flow sensors, which provide important information about processes responsible for voltage and/or current generation in the moving liquids. The investigated sensors were fabricated using epitaxial graphene grown on SiC substrates [4]. We found that the generated signals have two components, of which one is dependent and the other one is independent of the liquid flow direction. Using a measurement configuration with additional counter and reference electrodes, we were able to separate these two effects. Additionally, our method allowed us to partially eliminate random noise and background jumps in the observed signal. The performed experiments included measurements for different flow velocities, directions of fluid flow, different configurations of electrodes and various ion concentrations in aqueous solutions. The obtained results are discussed in terms of electrochemical effects, drag effect and modifications of electrical double layer that appears in a fluid in contact with graphene.

[1] J. Yin et al., *Nature Nanotechnology* **9**, 378-383 (2014)

[2] P. Dhiman et al., *Nano Lett.* **11**, 3123–3127 (2011)

[3] J. Yin et al., *Nano Lett.* **12**, 1736–1741 (2012)

[4] W. Strupinski et al., *Nano Lett* **11** 1786-1791 (2011)