2D materials for the quantum age

Zeila Zanolli
Chemistry Department & Debye Institute for Nanomaterials Science, Utrecht University, Princetonplein 1, Utrecht, The Netherlands
z.zanolli@uu.nl

Major advances in human civilization are driven by developments in materials. This is such a remarkable feature that historical eras are named after the material (and the related technology) that dominated that time. Today we live in the silicon era: Silicon technology enables our modern way of life via mobile phones, computers, automation. However, we are reaching the limits of silicon technology, as the related energy demand is not sustainable. It is time to move forward. As a scientist, I work to answer the question: what is the material that will enable the next revolution?

In this talk, I will present my personal perspective to answer this general question. Using the predictive power of first-principles techniques, I will show that a possible way forward is to design new materials, exploiting the quantum effects emerging at reduced dimensionality and at interfaces. By looking at the intersection of topological materials, interfaces, and spin-based electronics, we will see that it is possible to understand and, hence, control key parameters for next-generation devices as spin injection [1], topological (dissipationless) carrier transport [2], spin lifetime [3] and defects signatures [4] in 2D layered materials. Finally, we will discuss to what extent the monolayer physical/chemical properties persist in thin films, up to the mesoscale. [5, 6].

References

[1] Z. Zanolli, Sci. Rep. 6 (2016) 31346
[2] Z. Zanolli, C. Niu, G. Bihlmayer, Y. Mokrousov, P. Mavropoulos, M. J. Verstraete, S. Blügel, Phys. Rev. B 98 (2018) 155404
[3] M. Ersfeld, F. Volmer, P. M. M. C. de Melo, R. de Winter, M. Heithoff, Z. Zanolli, Ch. Stampfer, M. J. Verstraete, B. Beschoten, Nano Lett. 19 (2019) 4083
[4] Pedro M. M. C. de Melo, Z. Zanolli, M. J. Verstraete, Adv. Quantum Technol. **3** (2021) 2000118
[5] I. Ronneberger, Z. Zanolli, M. Wuttig, R. Mazzarello, Advanced Materials **32**, (2020) 2001033
[6] A. Dewandre, M. J. Verstraete, N. Grobert, Z. Zanolli, *J. Phys. Mater.* **2** (2019) 044005 https://doi.org/10.1088/2515-7639/ab3513

Figures

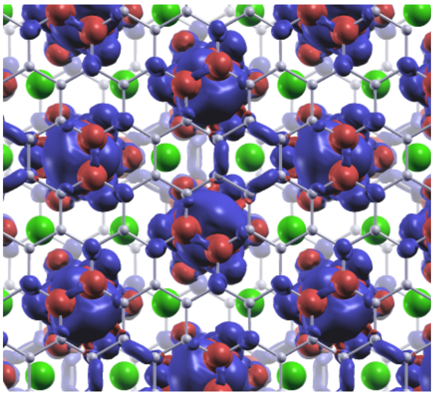

Figure 1: *Spin density induced in non-magnetic graphene by proximity interaction with a magnetic substrate*