From surfaces physics to two-dimensional materials – and why you should not be afraid of serendipity

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The interaction of ion beams with surfaces and solids has been studied for decades. Famous physicists such as Bohr, Bethe, and Bloch have worked in this field, trying to describe the plethora of mechanisms that occur when an ion interacts with a solid. Nowadays, ion beams are well-established and reliable tools used, for example, in cancer therapy, in the semiconductor industry for doping, shaping and cutting, or for material analysis. On the other-hand, despite those early efforts, understanding of the fundamental mechanism at the microscopic level has not progressed very far because of the time and energy scales involved. Being a surface scientist by education, I have introduced two-dimensional materials as target material for the study of ion-solid-interactions. Due to their well-defined thickness, flexible preparation, and the wide range of available materials, they represent an ideal target material, and we have studied the interaction of ions of different types with surfaces [1] and 2D materials (see Fig.1) [2]. In my talk I will discuss different aspects of ions beams interacting with surfaces. I will relate these to the various stages of my own academic career in an attempt to show how the interplay of creativity, perseverance and, las but not least, serendipity has accompanied my scientific journey.

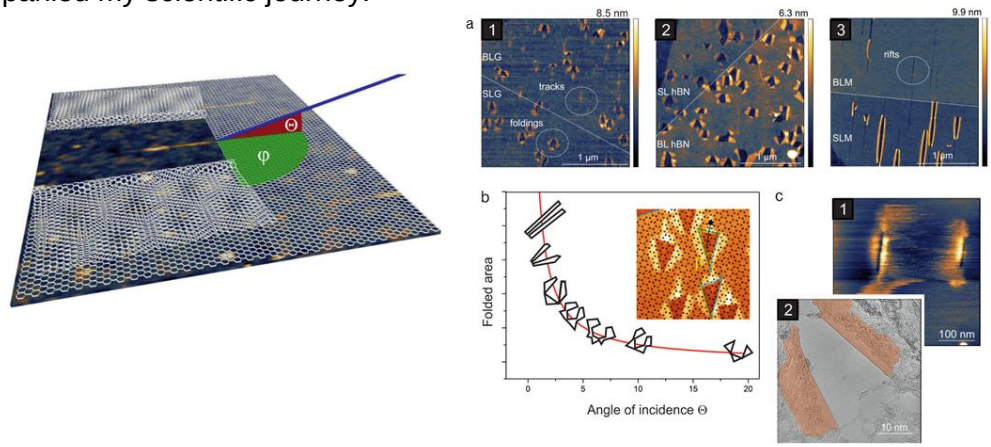

Figure 1. Folding of graphene and other 2D materials by ion irradiation. The sketch visualizes the backfolded graphene after an ion has impinged onto the surface under a grazing angle of incidence Θ (a) Foldings imaged by AFM in (1) single and bilayer graphene, (2) hBN, and (3) MoS_2. (b) The shape of the graphene folding pattern depends strongly on Θ. At larger angles, the pattern consists of multiple foldings oriented along low-indexed crystallographic directions of graphene as shown in the inset in (b), while under very grazing incidence the azimuthal angle determines the direction of the two foldings, which are aligned along the ion trajectory. The substrate also influences shape and size of the foldings. AFM images of suspended graphene show slits (c1), which are small foldings, as can be seen in atomically resolved TEM images (c2).

References

[1] F. Aumayr, S. Facsko, A. El-Said, C. Trautmann and M. Schleberger: Single ion induced surface nanostructures: A comparison between slow highly charged and swift heavy ions
J. Phys.: Condens. Matter **2011**, *23*, 393001
[2] M. Schleberger and J. Kotakoski: 2D Material Science: Defect Engineering by Particle Irradiation, *Materials* **2018**, *11*, 1885