From energy dissipation on Dirac materials to open questions in 2D materials growth

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We have been studying various Dirac materials including topological insulators such as Bi_2Se_3 using helium atom scattering[1]. Atom-surface scattering has been demonstrated to be a sensitive probe to determine the surface phonon dispersion and the electron-phonon (e-ph) coupling[1-4], a quantity that determines energy losses in surface electronic transport. We will discuss the influence of the dimensionality on e-ph coupling, when considering low-dimensional or 2D systems[1,5].

Furthermore, we will discuss recent experimental findings about the growth of hexagonal boron nitride (hBN) based on helium spin-echo measurements[7]. A common growth method for 2D materials is chemical vapour deposition, were a gas-phase precursor is deposited on a solid substrate, diffuses, dehydrogenates and eventually attaches to a growing 2D cluster[8]. The dehydrogenation of the precursor can occur in several steps and while studying such phenomena is crucial for understanding the growth, it has only briefly been discussed in the context of graphene formation[9] and nothing is known about hBN or other 2D materials. E.g, the thermodynamics of intermediate products, may lead to meta-stable phases, yet such phase-diagrams have not been reported up to now.

We will illustrate the existence of such phases based on our study of h-BN growth on Ru(0001). In contrast to the reportedstructure following the “ideal” growth conditions, we find a (3×3) meta-stable phase, which is attributed to partial dehydrogenation of the precursor. Furthermore, we find a post h-BN (3×4) phase which emerges upon excess deposition under certain conditions. Our findings shed light on open questions and a largely unexplored area considering the growth of 2D materials.

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