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Building material foundations for topological quantum computing

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1040, Floragasse 7, 1st Floor, Seminar Room 362
Host: G. Strasser

Abstract

One of the most troublesome roadblocks to practical quantum computers is undesirable coupling of qubits to noisy external environment which perturbs the fragile quantum states involved in information retention and processing. Topological superconductivity supporting so called protected boundary states and quasi-particles with non-Abelian statistics such as Majorana fermions may be the solution. InSb quantum wells (QW) are one of the most desirable material systems for the top-down approach in realizing Majorana bound states for topological quantum computing. Because of the lack of suitable semi-insulating substrates lattice-matched to InSb such QWs are typically grown on AlInSb metamorphic buffers deposited on GaAs substrates. However, a high density of pyramid-shaped hillocks forms on such buffers, due to the spiral growth around the screw components of threading dislocations. Their presence may cause undesirable spatial modulation in AlInSb barrier composition as well as variations in InSb QW thickness, increasing electron scattering rates and trapping probability. Suppression of hillocks is thus essential from the perspective of quantum device performance and formation of robust bound Majoranas. Growth on vicinal surfaces has been reported as a path for suppressing the hillock formation. However, establishing the precise offcut angle is critical and may depend on the layer composition and growth conditions. Recently we proposed that the vicinal surfaces defined by the naturally formed hillock facets have the exact surface orientation needed to achieve large-area hillock-free surfaces.[1] In this presentation I will present the results which verify this hypothesis. Prior to focusing on the outlined above project I will introduce the relevant background and also give a brief overview of the present activities in my research group and the Molecular Beam Epitaxy lab at the Quantum Nano Centre of the University of Waterloo.

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[1] Y. Shi, D. Gosselink, K. Gharavi, J. Baugh and Z. R. Wasilewski, J. Cryst. Growth (2017). doi: 10.1016/j.jcrysgro.2017.03.043

FWF Der Wissenschaftsfonds.

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