Quantum Spin Hall Effect at Elevated Temperatures in InAs/GaInSb/InAs Trilayer Quantum Wells

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Topological Insulators (TIs) exhibiting the Quantum Spin Hall effect (QSHE) have been widely recognized as promising candidates for next-generation electronic devices due to their dissipationless and spin-polarized electronic properties [1-3]. To be suitable for device applications, TIs must exhibit specific characteristics such as scalability, reproducibility, tunability (*e.g.*, with an electric field), and robustness of the helical edge channels beyond cryogenic temperatures. Although many materials have been predicted to host the QSHE, only a few have demonstrated the underlying transport signatures, but no material platform checked all the other characteristics mentioned above [1,2]. The 2D TIs based on the InAs/GaSb material system profit from compatibility with the semiconductor industry and major growth and processing technology developed. Moreover, the possible phase transition between a TI and a normal insulating (NI) phase [4] and the rather temperature-insensitive band ordering [5,6] make this material system interesting for potential device applications. However, until now, helical edge channels have only been demonstrated at a temperature of a few Kelvin for InAs/GaSb BQWs [3]. Here, we present a TI based on an InAs/GaInSb/InAs trilayer quantum well (TQW) exhibiting the QSHE even at elevated temperatures. Microscopic devices with several contact lengths L and L_{NL} of a few micrometers were fabricated (see Fig. 1(a)) and showed the expected length-independent quantized resistance both in local ($R_{0,3;1,2}$ in Fig. 1(b)) and nonlocal ($R_{0,1;2,3}$ in Fig. 1(c)) geometries. Finally, we demonstrated the robustness of the QSHE in our devices up to T = 60 K (Fig. 1(d)), with the prospect of achieving even higher temperatures. Our findings pave the way for the integration of TIs based on the InAs/GaInSb material system in topological field-effect devices.

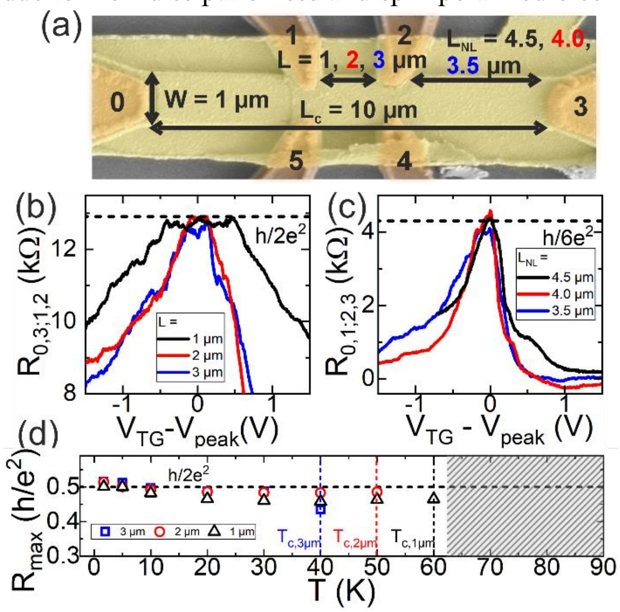

Fig.1. (a) Image of a microscopic Hall bar with the different contacts and lengths labeled. (b) Quantized local resistance ($R_{0,3;1,2}$) and (c) nonlocal resistance ($R_{0,1;2,3}$) as a function of top-gate voltage for different lengths. (d) Temperature dependence of the resistance in the gap R_{max} for the local configuration.

References

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