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Spin-polarized Majorana zero modes in penta-silicene nanoribbons

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We report the possibility of obtaining Majorana zero modes (MZMs) in straight, highly perfect, and massively aligned atom-thin penta-silicene nanoribbons (p-SiNRs) with a very high aspect ratio, purely composed of silicon pentagonal building blocks, and grown by molecular beam epitaxy on the (110) surface a silver crystal template2,3. They could constitute the experimental realization of the generic Kitaev toy model3,4. The spinless and full spin p-SiNRs with p-wave superconducting pairing reveal the emergence of topologically protected MZMs at opposite ends of the p-SiNRs. Besides the first nearest neighbor hopping term and p-wave superconducting pairing we consider an external magnetic field perpendicularly applied to the nanoribbon plane and an intrinsic Rashba spin-orbit coupling. The dispersion relation profiles show the closing and reopening of the superconducting gap for only one spin component, suggesting a spin-polarized topological phase transition (TPT). Along with this TPT, the energy spectrum as a function of the p-SiNR chemical potential exhibits zero-energy states and preferential spin direction. It is associated with nonoverlapping wave functions well-localized at the opposite extremities of the superconducting p-SiNRs. Hence, we show theoretically that the p-SiNRs could constitute a tantalizing new platform for MZMs.

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