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Independent control of spin and valley by electric field or temperature in designed silicene-based devices[1] XUECHAO ZHAI, Information Physics Research Center, Nanjing University of Posts and Telecommunications — We show that spin and valley can be completely and independently controlled by electric field or temperature in our designed silicene devices. First, we find that a bipolar spin-valley diode effect can be driven and controlled by applying longitudinal biases through a silicene ferromagnetic-field/interlayer-electric (Ez) field junction.This effect indicates that only one-spin (the other spin) electrons from one valley (the other valley) contribute to the conductance under positive (negative) biases, arising from the specific band-matching tunneling mechanism. By reversing the Ez direction, the conductive valley can be switched to the other while the spin orientation is reserved. Second, we propose a silicene caloritronic field effect transistor constructed of two ferromagnetic electrodes and a central Ez-field region, and find that a valley Seebeck effect is driven by a temperature difference, with currents from two different valleys flowing in opposite directions. By tuning the Ez field, a unique transition from valley Seebeck effect to spin Seebeck effect is observed. These findings provide a platform for encoding information simultaneously by the valley and spin quantum numbers of electrons in future logic circuits.

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Xuechao Zhai
Information Physics Research Center, Nanjing University of Posts and Telecommunications

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