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Band-Gap Sensitived Seebeck Effect in Heavy Group-IV Monolayers

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We have systematically investigated the spin- and valley-dependent Seebeck effect in irradiated heavy group-IV monolayers including silicene, germanene, and stanene by means of semi-classical Boltzmann equation in diffusive regime. Due to the interplay of strong intrinsic spin-orbit coupling, perpendicular electric field, and off-resonant light field, the temperature-driven spin and valley conductivity can be controllable effectively. Except for numerical results, the amplitude of Seebeck coefficient is analyzed and found to be in direct proportion to the band gap at high temperature. It supplies a flexible method to modulate the Seebeck effect. In addition, we have compared the thermoelectric transport properties of different group-IV materials and found that the figure of merit shows great enhancement from silicene to stanene. These findings are excepted to provide a platform for the heavy group-IV materials in future spin–valley thermal and energy-saving devices.

Keywords: Seebeck effect, heavy group-IV materials, off-resonant light, spin and valley caloritronics.