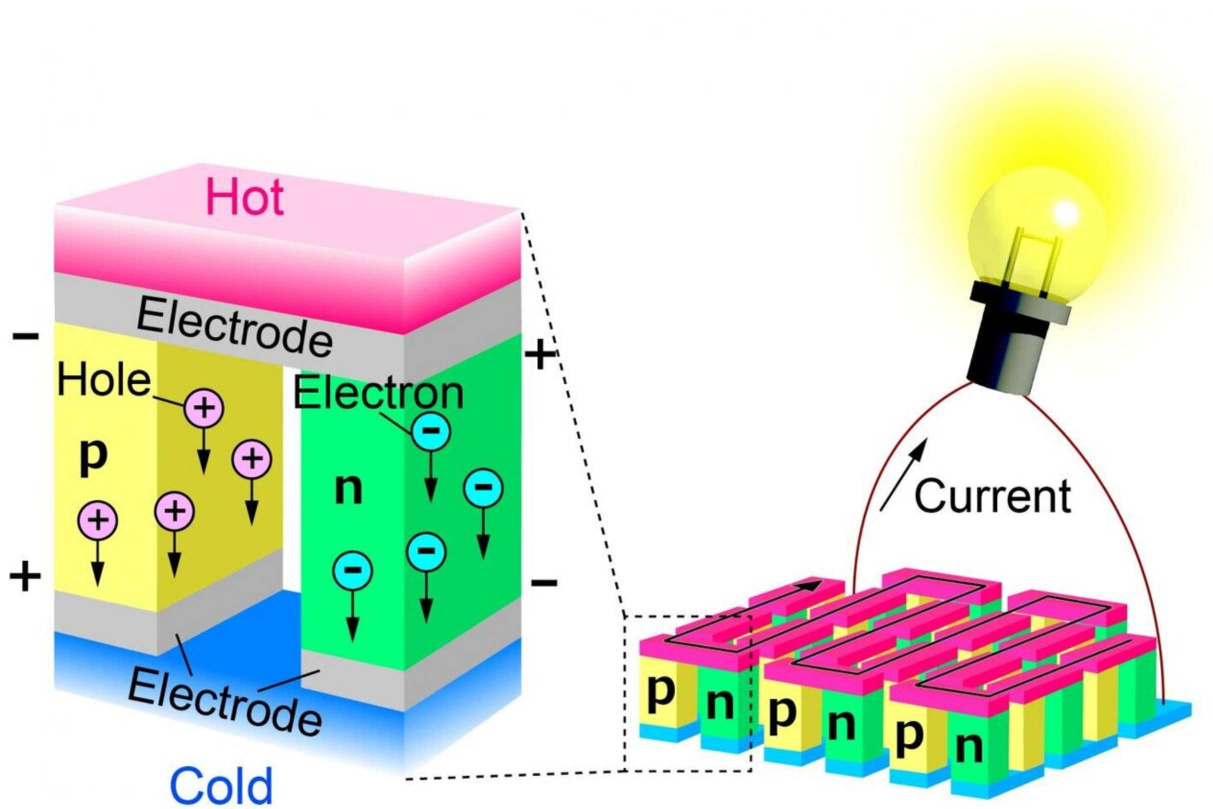
Multiple semiconductor type switching to boost thermoelectric conversion of waste heat

December 9 2020

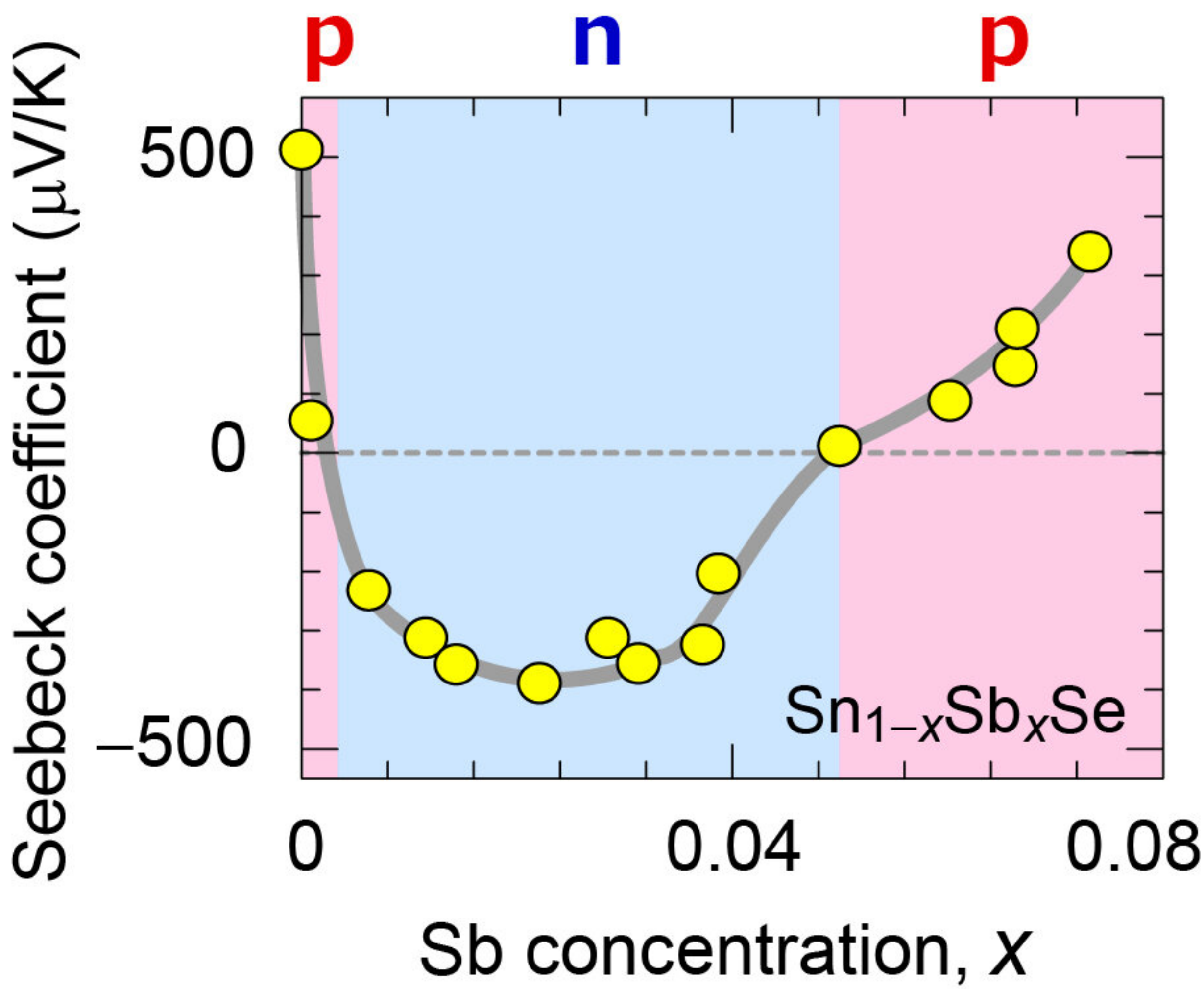


Tin monoselenide (SnSe), when doped with antimony (Sb), can make for a suitable candidate for the design of thermoelectric conversion elements (p-n junction device). Credit: Tokyo Tech

In recent years, the energy consumption in developed countries has been rather wasteful. Nearly two-thirds of the total energy is typically discarded into the environment as "waste heat," which ends up contributing to global warming. Finding a way to productively use this heat has been at the forefront of every material researcher's priority.

One of the various possible ways to recover this waste heat as electricity is using what is known as "thermoelectric conversion"—a process that uses temperature difference in semiconductors to directly convert into electric voltage. Thermoelectric devices include p-type and n-type semiconductors with two types of charge carriers, i.e. electron and hole. The p-type and n-type semiconductors are connected in series to produce a large thermoelectric voltage. Therefore, it is necessary to develop the both p-type and n-type semiconductors with high thermoelectric conversion efficiency.

One particular semiconductor material that scientists have recently turned their attention to is tin monoselenide (SnSe), which reportedly exhibits the world's highest thermoelectric conversion performance index ZT value. However, SnSe is incapable of controlling the charge carrier type with ease. Doping with alkali ions improves p-type thermoelectric performance but the alkali ions are volatile and diffusive elements, and are not suitable for high-temperature applications. Adding bismuth and iodine to make it n-type, on the other hand, results in low electron concentrations.



SnSe starts out with p-type conduction at low Sb concentrations (

Citation: Multiple semiconductor type switching to boost thermoelectric conversion of waste heat (2020, December 9) retrieved 26 June 2024 from https://phys.org/news/2020-12-multiple-semiconductor-boost-thermoelectric-conversion.html