Design and Simulation of Out-of-Plane Nanomaterial-Based Thermocouples

Our contribution indicates a novel solution for the development of the field of low-cost, printed thermocouples for energy harvesting and autonomous thermal sensors. Particularly, our work stems from the observation that the totality of printed thermocouples presented in literature relies on the conversion of a thermal gradient parallel to the plane of material deposition. This strategy is inherently inefficient and rarely applicable in real life scenarios. To overcome these issues, we introduced a novel concept of printed thermocouples, which use 3D-printing to define a vertical structure, upon which an out-of-plane thermal gradient can form and be harvested. Here, we perform thermoelectrical multi-physics simulations, employing parameters of nanomaterials extracted from literature, to show how this approach can lead to generate hundreds of microwatt in typical work conditions. Given their elevated thermopower, these structures could be employed both as autonomous sensors and energy harvesters in Internet of Things applications.