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Flexible thin-film planar Peltier microcooler

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The present work reports the fabrication and characterization of the first planar Peltier microcooler on flexible substrate. The microcooler was fabricated on flexible Kapton© polyimide substrate, 25 μm thickness, using Bi_2Te_3 and Sb_2Te_3 thermoelectric elements, deposited by thermal co-evaporation method.
The cold area of the device (4 mm2) is cooled using four pair of thermoelectric elements, connected in series with aluminum / nickel contacts. Flexible substrates add uncommon mechanical properties to the composite film-substrate and enable their integration with many novel types of electronic devices. Kapton was chosen as substrate because of its low thermal conductivity (0.16 $W.m^{-1}.K^{-1}$), enabling higher performance on cooler devices. The value of thermal expansion coefficient of Kapton (12×10^{-6} K^{-1}), which closely matches the thermal expansion coefficient of the telluride films, reduces residual stress and increases adhesion of thermoelectric films. Thermoelectric films were deposited by co-evaporation of Bismuth and Tellurium or Antimony and Tellurium respectively for the Bi_2Te_3 or Sb_2Te_3 films. Optimal growing deposition parameters allow the fabrication of films with power factor of 4.8 $W.K^{-2}.m^{-1}$ and 2.8 $W.K^{-2}.m^{-1}$ respectively for Bi_2Te_3 and Sb_2Te_3, values that are comparable with the best published results for the same material, under various fabrication methods (thermal co-evaporation, sputtering, MOCVD, flash-evaporation, or ECD).
The performance of Peltier microcooler was analyzed by infrared image microscope, on still-air and under vacuum conditions, and the temperature difference between the cold side and the hot side of the device was measured and compared with literature available for Peltier microcoolers on rigid substrates.