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Heavily phosphorus doped polycrystalline silicon with possible applications in the field of thermoelectrics

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Until recently, the field of thermoelectrics marked silicon as an utterly poorly performing material. However, in the recent few years, due to development of the experimental methods that influenced the decrease of the grain size in the polycrystalline material and lowering of dimensionality, silicon gained increased attention. In this study, we analyzed heavily phosphorus doped poylcrystalline silicon samples prepared in the following way: the amorphous samples were obtained using parallel flows of silane and phosphine in LPCVD furnace at 530 ^{o}C and thereafter subjected to rapid thermal annealing in different time intervals at 950 ^{o}C. According to SIMS, the concentration of phosphorus is $2 \cdot 10^{20} cm^{-3}$ for each sample. Samples were analyzed using Raman spectroscopy, SEM, four point probe, low temperature resistivity and Seebeck coefficient measurements. Samples are in the metallic regime from the lowest temperatures measured. Seebeck coefficient shows linear temperature dependence above 150 K where the resistivity shows the $T^{3/2}$ dependence in the same temperature range.
The quality of samples obtained in this way was evaluated by comparing them to some crystalline samples in the same dopant concentration range. We also discuss application possibilities of these samples as thermoelectrics and in microelectronics.