Ultra-doped Ge: old material with new functionalities

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One of the main obstacles towards wide application of Ge in nanoelectronics is the lack of an efficient doping method for the fabrication of heavily doped Ge layers with well controlled junction depth. In fact, n-type doping of Ge is a key bottleneck in the realization of advanced negative-channel metal-oxide-semiconductor (NMOS) devices. Here we use ion implantation followed by flash-lamp (FLA) annealing for the fabrication of heavily doped Ge with comparably high mobility. In contrast to conventional annealing procedures, rear-side FLA leads to full recrystallization of Ge and dopant activation independently of pre-treatment. The maximum carrier concentration is well above 10^{20} cm^{-3} for n-type and above 10^{21} for p-type doping. The recrystallization mechanism and the dopant distribution during rear-side FLA are discussed in detail.

In this work, we report on the strong mid-IR plasmon absorption from heavily P-doped Ge thin films and superconductivity in Ga implanted Ge obtained by non-equilibrium thermal processing. Ultra-doped Ge layers were fabricated by ion implantation of P or Ga ions followed by rear-side flash lamp annealing in the millisecond range. This approach, in contrast to conventional annealing procedures, leads to full recrystallization of Ge films and high dopant activation. In this way single crystalline Ge thin films free of defects were obtained. The mid-IR plasmon spectral response at room temperature from those samples was characterized by means of Fourier transform infrared spectroscopy. It is proven that the position of the plasmonic resonance frequency signal can be tuned as a function of the P concentration.