**Figure captions**

Fig. S1. (a) Left: Energy diagrams of isolated c-Ge and c-Si. Right: energy diagram of c-Ge/c-Si system at thermal equilibrium after Fermi level pinning. The valence band offset between c-Ge and c-Si results in a quantum well for holes carrier. (b) Left: Energy diagrams of isolated c-Ge and a-Si. Right: energy diagram of c-Ge/a-Si system at thermal equilibrium after Fermi level pinning. The valence band offset between c-Ge and a-Si results in a more pronounced quantum well for holes carrier compared to the c-Ge/c-Si system.

Fig. S2. SEM image of a Ge nanowire covered by narrow Si nanowires.