Raman spectrum of SiGe NWs. Compositional and electromagnetic amplification aspects*

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The growth of semiconductor alloyed NWs is receiving increasing attention, because of the continuous tunability of their physical properties by the intrinsic effect of the alloy composition, which opens the possibility of fabricating a wide range of heterostructured devices based on NWs, necessary for the design of advanced nanodevices. In particular, SiGe alloys present a huge interest, because of the excellent properties of this alloy for high frequency devices, as well as the possibilities offered in the modulation of the band gap, and the electric and thermal transports. The growth of SiGe NWs is more challenging than that of single NWs, either Si or Ge, because the solubilities of Si and Ge in the metal catalysts are different, which can introduce instabilities that affect the shape and composition of the NWs, as well as the abruptness of the heterointerfaces. Therefore, the control of the NW composition is fundamental for the fabrication of high quality heterostructured NWs. Raman scattering has been frequently used as a characterization tool for semiconductor NWs. The measurement of the Raman spectrum of NWs is challenging because of the low efficiency of the Raman scattering, which results in very weak signals for very small sampling volumes. The composition can be determined from the characteristic Raman spectrum when the temperature effects are removed; however, the distribution of the composition in SiGe NWs, as deduced from the Raman spectra, presents anomalies, in particular, Ge concentration higher than the concentration measured by EDX in the transmission electron microscope (TEM). These anomalies are related to the surface segregation of Ge, which results in the inhomogeneous distribution of Ge according to the Raman spectrum. The interaction between the electric field associated with the laser beam and the NW permits to understand the Raman results in view of the distribution of the electric field inside the NW. Both Raman spectra and finite element simulations of the electric field inside the NWs are presented.

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