This thesis investigates growth of III – V semiconductor nanowire (NW) arrays, in a core-branch architecture, with the aim to develop diffusion driven light emitting diodes (LED) on NWs. Diffusion driven LEDs are based on the concept of decoupling the active region from the *p-n* junction. The carriers are injected by diffusion in the active region, because of the bandgap difference between the *pn* junction and the active region. This concept can be used in NW structures where tree structures are grown with high bandgap cores and low bandgap branches. The small diameter of the branches facilitates light extraction and removes the limitation of total internal reflection. The first part of the thesis focuses on studying the deposition parameters of Au particles on the sidewalls of the core NWs. These particles act as catalysts for branch growth. The second part of the thesis focuses on the growth of branches from homostructures (InP-InP) and heterostructures (InGaP-InGaP) where the Ga content in the core is higher than in the branches. We demonstrate high density branch growth distributed along the entire core length. Finally, we present some results from photoluminescence measurements in heterostructure core-branch NWs. The results presented in this thesis are intended to contribute to the development of a new and promising LED architecture.