It is a surprisingly undeniable fact that the RF performance (including the gain and the noise) of an SIS mixer is solely determined by its DC IV characteristic, supposing that the embedding electromagnetic environment is known. In other word, the geometric features of the IV curve includes all the physical information that affect its RF performance. However, it is not yet well known what features of the IV curves are responsible for determining the RF performance, except the well understood features including leakage current, gap voltage and normal resistance. This study focuses on two important features of IV curves, namely the sharpness of the onset of the current at gap voltage and the knee structure caused by proximity effect in the electrodes of the tunnel junction. We use numerical models to generate series of IVs, which are different in above mentioned two features while keeping other parameters unchanged, and performance simulations with these IV curves. The simulation results show that the knee structure does not affect the RF performance given that the gap voltage is not reduced by proximity effect, and the onset sharpness at voltage gap significantly reduces the sensitivity of an SIS mixer when it operates at long millimeter waves, where the transition width is comparable to the photon step width.

Fig. 1. The simulated pumped IV curves and conversion gains of SIS mixers with different significance in knee structure above gap voltage.