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Experimental two-photon absorption in silicon avalanche photodiode for infrared single photon detection[1] YANI ZUO, ZHENGYONG LI, GE ZHANG, ZHENG YANG, WEIHUA LIU, CHONGQING WU, Beijing Jiaotong University, INSTITUTE OF OPTICAL INFORMATION TEAM — As an indirect band gap material, silicon avalanche diode (Si APD) possesses much more interesting features in nonlinear absorption especially the two-photon absorption (TPA). We experimentally investigate in detail the TPA in Si APD for infrared photons with different frequency, intensity, under different bias voltage. For frequency from 186.3 to 196.1 THz, the TPA rate goes up and then decreases at an optimal frequency around 172 THz for the APD under test. We further observe, for the first time according to our knowledge, that the TPA rate actually goes down when photon intensity exceeds a certain value, which is satisfied with the theoretical prediction given in Phys. Rev. B 77, 125219, that is, the TPA probability is affected by the dressing-induced energy level detuning. Moreover, we find that the TPA process is sensitive to the polarization state of the input photons, which can cause the absorption rate change over 15%. Based on the TPA in Si APD, we successfully detect the infrared single photons at 1310-nm with high quantum efficiency (65%) at room temperature assisted with a 1550-nm pump laser.

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