On-demand generation of indistinguishable single photons is a key technology for achieving optical quantum information processing. Since use of optical fibers is inevitable in practical implementations of many protocols, direct generation of photons into the fiber is advantageous and therefore a single quantum emitter coupled strongly to a fiber is a promising candidate for a practical single photon source. In this study, we theoretically investigate a cavity-QED setup composed of a quantum dot, a microtoroid cavity and a tapered fiber [Figure (a)]. The quantum dot is excited from the side by a $\pi$–pulse and emits a photon dominantly into the cavity due to the Purcell effect. The emitted photon is forwarded to one of the two output ports under adequate mixing by a beam splitter. Under practical cavity-QED parameters $[(g, \kappa, \gamma) /2\pi=(200, 1000, 5)\text{MHz}]$ and a short $\pi$–pulse ($\sim100$fs), the current setup exhibits a good performance as a single photon source: the single-photon probability $P_1$ reaches 0.98 while the multiple-photon probability $P_m$ is negligibly small [Figure (b)]. This work is supported by SCOPE (111507004) and KAKENHI(25400417).