Parity-time symmetry single-mode double-microdisk InGaAs quantntum dot lasers

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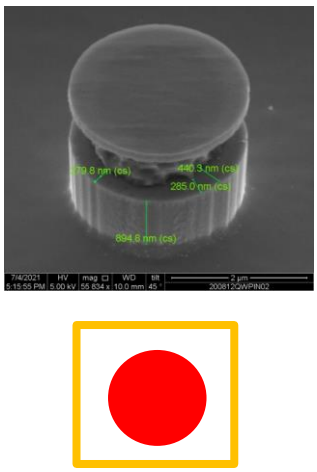
We successfully demonstrate the parity-time symmetry (PT-symmetry) single-mode lasing operation of laterally coupled double-microdisk lasers. The microdisk lasers of disk diameter = 2.85 μm are fabricated by using MBE-grown InGaAs quantum dots as the gain medium. The gain materials of dots-in-a-well (DWELL) structures are grown on (001) n^+-GaAs substrate by molecular beam epitaxy. The wafer structure consists of a 1 μm-thick $Al_{0.5}Ga_{0.5}As$ sacrifice layer, and an active layer comprised of a stack of six InGaAs DWELLs. In spite of the lasing output of multiple whispering-gallery modes (WGMs) from the single microdisk lasers, the laterally coupled double-microdisk lasers achieve single WGM lasing under gain-loss contrast pumping condition, literally pumping only one disk for the double- microdisk. We change the air gap distance (*d*) for the coupled double-microdisk structures to change the coupling strength (*k*) between the microdisks. Under single selective pumping (gain-loss contrast) at room temperature, the laterally coupled double microdisk lasers of *d* = 150nm, and 200nm show single lasing mode at WGM m = 1, 21 (λ = 1199nm). We also fabricate the double-microdisk lasers by coating the microdisks with HfO_2 to change the coupling strength *k*. Under single selective pumping, the HfO_2–coated double microdisk lasers show a single lasing mode at WGM m = 1, 20 (λ= 1277nm).



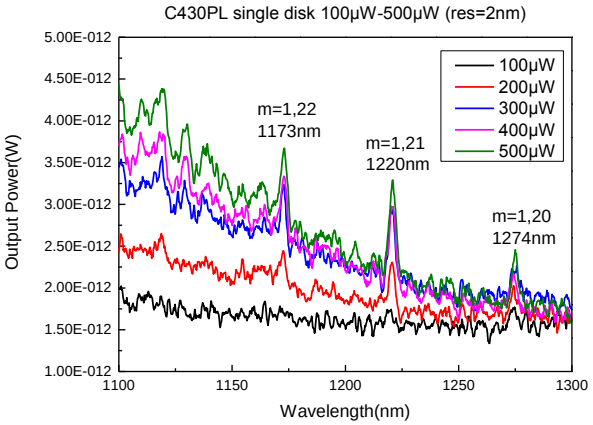
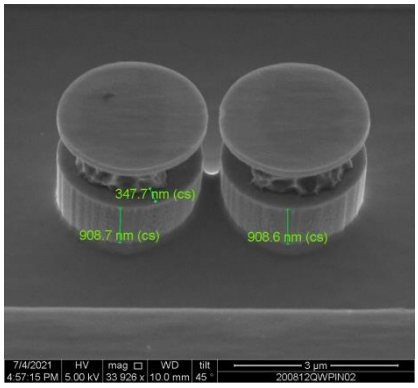
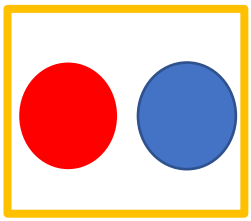


Fig. 1. SEM picture fora single microdisk of diameter = 2.85 μm, and the lasing output of multiple WGMs .





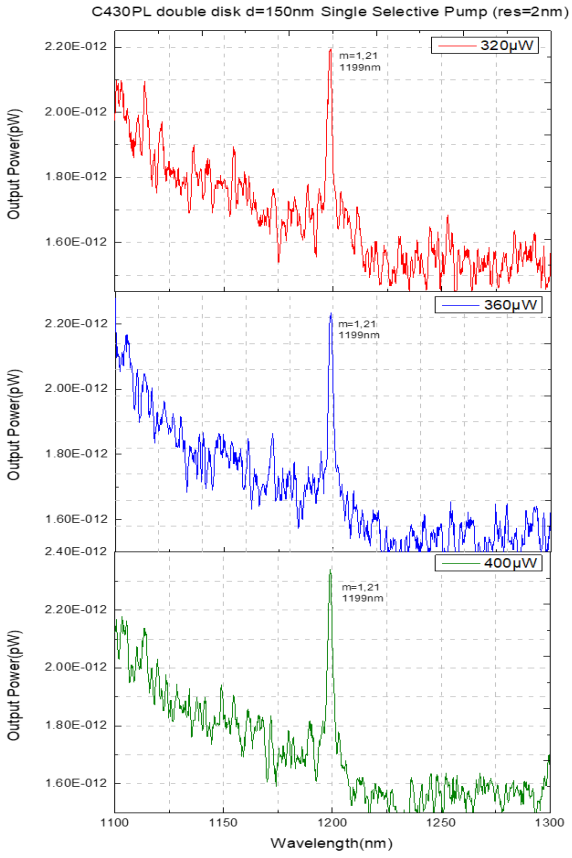


Fig. 2. Under single selective pumping (gain-loss contrast) at room temperature, single lasing mode at WGM m = 1,21 (λ = 1199nm) is obtained for the laterally coupled double- microdisk laser of *d* = 150nm.