Polariton condensates' circuitry: turning bends

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We investigate how the circular polarization degree of traveling polariton condensates is affected as they traverse a bend in their path within a microcavity coupler structure [1, 2]. Within these structures, the condensates encounter two bends with the same rotational orientation: either clockwise or anti-clockwise, positioned on the left or right arm of the coupler, respectively. In both arms, after turning a bend, we observe a dominance of the condensates' circular polarized emission aligned with the helicity of the bend (Fig. 1).

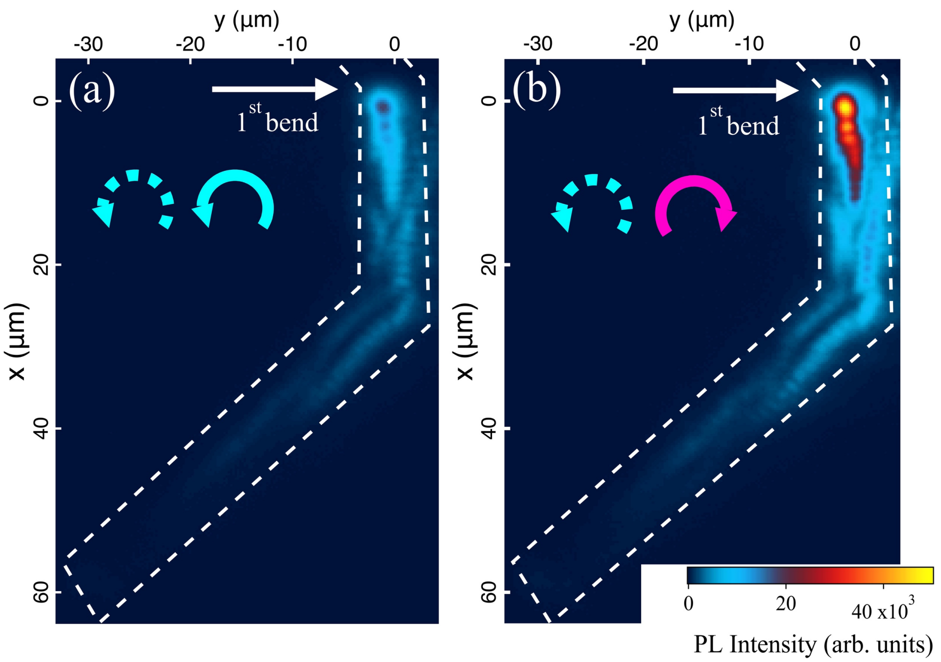

Fig.1. PL Intensity maps obtained after anti-clockwise circularly polarized excitation (dashed arrows) at the input terminal of device (not included in the images) detecting the anti-clockwise/clockwise (a/b) circularly polarized emission (solid arrows).

Our experiments involve a GaAs-based microcavity with coupler structures sculpted by reactive ion etching. Various structural parameters, such as the width and separation of the coupler's arms, as well as the coupling length, can be adjusted. The couplers are cooled to 15 K inside a cryostat and optically excited using 2 ps-long pulses from a Ti:Al_2O_3 laser. A combination of quarter-wave plates and linear polarizers enables the creation and detection of circular clockwise and anti-clockwise polarized emissions.

We selected a 6 µm wide coupler with a 20 µm coupling length and arms separated by 1.5 µm to ensure the isolation of each arm. Initially, we generate polariton condensates predominantly polarized circularly in the input terminal of the coupler. These condensates are then launched into the coupling area, passing through the first bend. Subsequently, we record time-integrated 2D emission maps (see Fig.1) and generate the corresponding circular polarization degree images (not shown), $P=(I_{\parallel}-I_{\perp})/(I_{\parallel}+I_{\perp})$, where $\parallel/\perp$ means parallel/perpendicular to the circular polarization of excitation. Our findings reveal that the emission intensity from condensates with circular polarization rotating in the same direction as the bend's rotation exceeds that of the perpendicular polarization. This results in a positive polarization degree when the circular polarization of excitation aligns with the direction of the polariton path's curvature. These results will be further analyzed in the light of simulations of the propagating condensates using the Gross-Pitaevskii equation.

References

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