プログラム名： 量子人工脳を量子ネットワークでつなぐ高度知識社会基盤の実現
PM 名： 山本喜久
プロジェクト名：量子シミュレーション

委 託 研 究 開 発

実 施 状 況 報 告 書（成果）

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研究開発課題名：

Development of semiconductor-based quantum simulators

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ウルツブルグ大学

研究開発責任者

Sven Hoefling

1. Activities, Accomplishment and Findings

In this period of the project, the Würzburg group has focused on the development and characterization of polariton-based quantum simulators. The technology platform, which was optimized in this project period, relied on deeply etching micropillar cavities via reactive ion etching. Despite the fact that deep etching of micropillar structures has a long tradition in the group, adapting this technology to the polariton platform to allow highest performance was a crucial task. This involves a careful optimization of passivation including planarization of the structures with polymers (Benzocyclobuthene). This task was accomplished in the last period, with the result that this technology can now be readily exploited for the fabrication of advanced polariton lattice structures and the definition of almost arbitrary potential landscapes.
As one example, we have successfully fabricated coupled micorpillars, which were etched in a strongly coupled microcavity. Those pillars were arranged in a honeycomb lattice, with the target to test their suitability to mimic the behavior of mass-less Dirac fermions in graphene. A, electron scanning micrograph image of the resulting lattice is shown in Fig 1.
Fig 2. Depicts optical measurements which were carried out on these structures: The measurements were performed under non-resonant pumping at a sample temperature of 10K. The luminescence from the polariton resonances is detected in a far-field setup, which allows to record to the full energy-momentum dispersion relation from the structured sample. As depicted in Fig 2, we could record all typical features of a graphene-type lattice structure in our polariton system, including the six high symmetry points (K,K') in the Brillouin zone and the linear Dirac dispersion of mass-less particles moving in a honeycomb lattice.

In a subsequent step, such structures will be optimized to allow to implement the effects related to spin-orbit coupling in the optical domain, which can yield topological behavior of propagating polaritons in edge states.

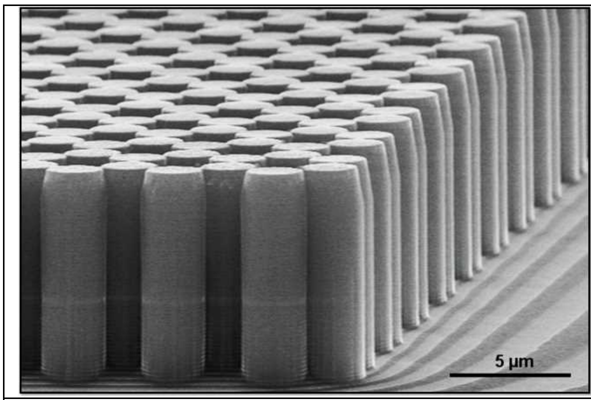

Fig 1: SEM image of Polaritonic Graphene. The structure was etched into a GaAs Microcavity, and mimics the physics of electrons in graphene in the optical domain.

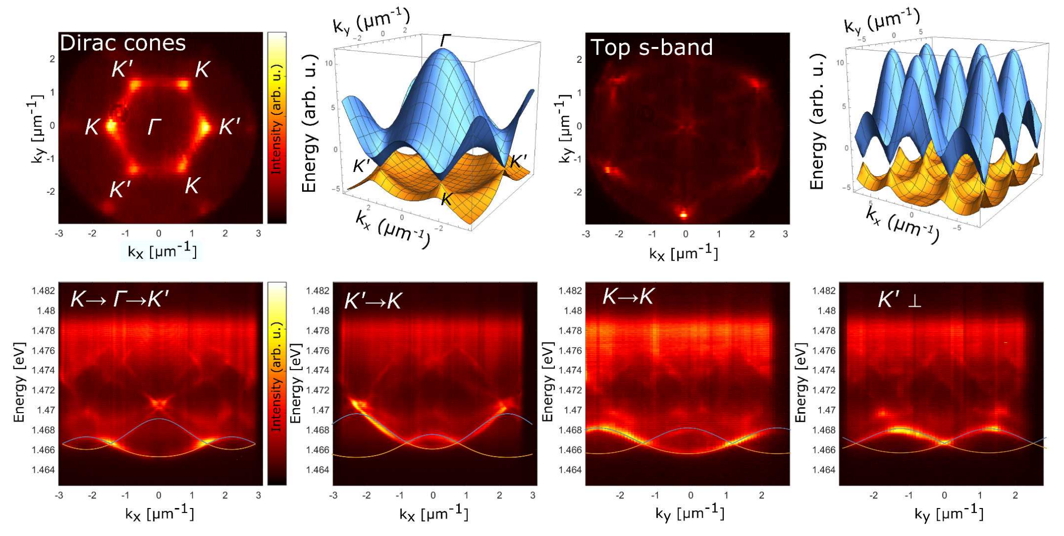

Fig 2. Spectroscopic measurements of the bandstructure of polaritonic graphene. The high symmetry points of the hexagonal brillouine zone are readily recognizable form the farfield images (K, K' Points). More importantly, the characteristic linear Dirac dispersion relation around the K, K' points can be seen.

2. Outreach, Events and Other Activities

None.