

Preface

Many people worldwide are fascinated from quantum information science and from the prospects of novel quantum technologies, such as quantum computing, quantum communication, quantum metrology, and quantum sensing. Semiconductor quantum dots (QDs) have been identified as a promising hardware for implementing the basic building blocks, e.g., stationary and flying qubits in the solid state. This is because individual charge carriers in QDs can be generated, manipulated, and coherently controlled and can be strongly decoupled from their environment, so that processes destroying the coherence of the qubits can be largely suppressed. Moreover, miniaturized and integrated solutions with existing semiconductor technology are foreseeable.

Through a huge common effort during the last nearly two decades, the semiconductor quantum optics community has made important progress in spin manipulation, the generation of indistinguishable single and entangled photon states, controlling the light–matter interaction, and spin–photon entanglement. For example, 16 years after the first demonstration of a QD-based triggered single-photon source near-optimal QD single-photon sources are nowadays available. They clearly outperform the up to now most used spontaneous parametric down-conversion sources with respect to brightness for comparable photon indistinguishability. This breakthrough was possible by the continuous and common research efforts of many research groups. Important milestones are the development of optimized QDs and microcavity structures, control of charge fluctuations, the introduction of a fully deterministic fabrication processes, and truly resonant optical excitation techniques of QDs.

Our book aims to provide an overview of recent exciting developments in the field of semiconductor quantum optics with quantum dots. The topics addressed include the theory of cavity QED and phonon-dressed light–matter interactions, resonantly excited quantum dots for indistinguishable single-photon emission, polarization, time-bin entangled photon generation, and superradiance. Spin properties with a special emphasis on noise properties, on ultrafast manipulation of exciton spins, on nanophotonic spin–photon interface and spin–photon

entanglement are also discussed. The last part is devoted to photonic integrated circuits with quantum dots.

Finally, I would like to thank all my colleagues for writing the various chapters and the very good cooperation in the course of outlining the book and editing their chapters.

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