Towards hybrid GaP/diamond integrated photonic networks

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The integration of negatively charged nitrogen vacancy (NV-) centers in diamond into solid-state photonic networks may enable scalable measurement-induced entanglement of the spins of spatially separated defects by interference of their emitted photons. Coupling of the NV- emission to all-diamond photonic cavities and waveguides has been demonstrated. This approach, however, lacks active optical device capabilities and may result in a degradation of the NV- properties. A hybrid photonic network utilizing GaP on top of diamond as the active waveguiding layer is proposed. GaP exhibits linear electro-optic properties, has a high refractive index n~3.31 and is transparent at the wavelength range of interest. This makes it an ideal material for the integration of active optical switches.

We present processing schemes for hybrid GaP/diamond systems that potentially allow for the realization of large-scale photonic networks including optical resonators for the enhancement of the NV- emission, switches, waveguides and grating couplers. Hybrid GaP/diamond systems were accomplished by two different methods: (1) molecular beam growth of GaP on the diamond substrate and (2) release and transfer of a submicron thick GaP sheet onto diamond. We present the fabrication of GaP waveguide and resonator structures on a diamond substrate, and evaluate the optical properties of the respective GaP layers with regard to future integration demands.