Defect center fluorescence from levitated diamonds

Researchers of the AG Nanooptik from the Department of Physics of the Humboldt-Universität zu Berlin achieved to levitate individual diamond particles while detecting the fluorescence emitted from the included defect centers. The team around Oliver Benson, member of **IRIS Adlershof**, writes in the scientific journal Applied Physics Letters how clusters of diamond nanoparticles were stabilized in an electrodynamic trap, a so-called Paul trap. The used diamond clusters with diameters between some micro- and a few hundred nanometers contained nitrogen vacancy (NV) defect centers. The defects are formed in the diamond lattice by a single nitrogen atom replacing a carbon atom with an adjacent lattice vacancy. Among the numerous known diamond defects, the NV defects show remarkable optical and electronic properties, which make them ideal candidates for a manifold of different applications, e.g. as single photon emitters in quantum optics or markers in biological experiments.

The particles were charged and sprayed into the trap by electrospray ionization in order to confine them in the oscillating electric field. The researchers demonstrated how particle stability can be controlled by the trap parameters. The measured fluorescence emission spectra proved that the trapped particles were indeed diamonds with NV defects.

The size determination of the trapped particles occurred after optical characterization. The free levitated diamonds were deposited from the trap on the end faces of optical fibers. The clean and

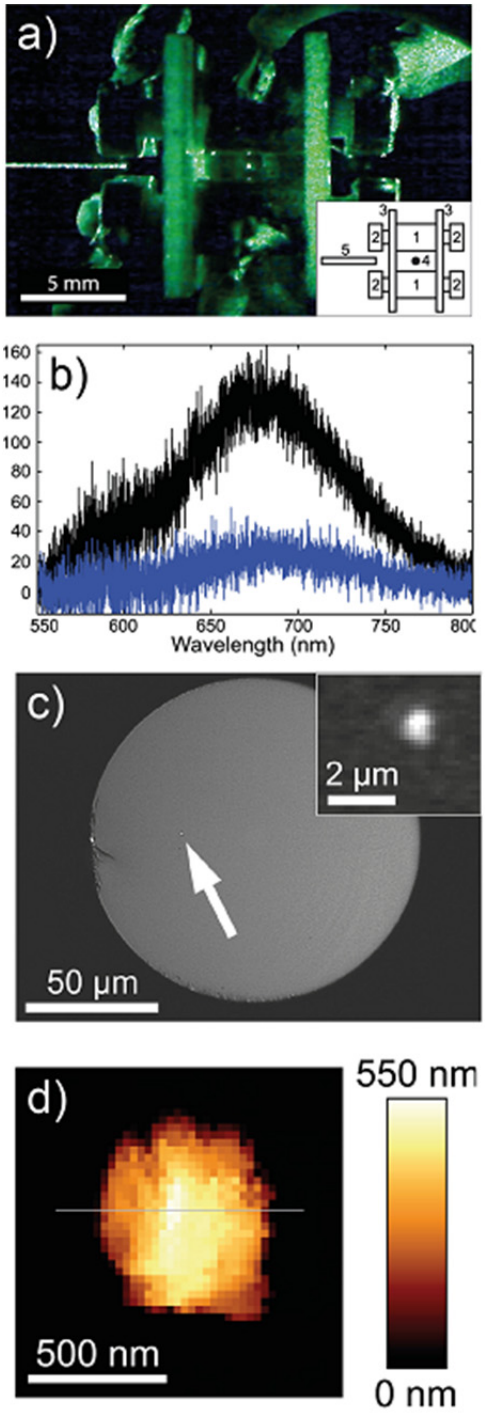

Figure: a) Diamond particle in linear Paul trap. 1: quadrupole electrodes, 2: end-cap electrodes, 3: mounting plates, 4: trapped diamond particle, 5: optical fiber. b) NV fluorescence spectra of single levitated diamond clusters with sizes of 900 nm (black curve) and 500 nm (blue curve). c) Optical microscope image of a diamond cluster deposited on a fiber end face. d) Atomic force microscope image of the same particle as in c).

delimited area of a fiber face enables easy retrieve of the particles. Subsequent measurements with optical and atomic force microscopes revealed that the smallest particles with detectable NV fluorescence have sizes around 500 nm, so far. This means, the collected fluorescence did not originate from one but several NV centers. A fact that could be already deduced from the fluorescence spectra.

The reason for this limitation can be found in the collection efficiency of the used microscope setup. The electrodes restrict the optical access to the trap center. For the next experiments, the researchers plan to involve improved trap geometries in order to detect the fluorescence emission of one single NV center in a single levitated diamond nanocrystal.

Towards investigation of optomechanical interactions in single nanometer-sized diamond crystals, the spatial isolation of diamond clusters in combination with the observation of fluorescence emission is one first important step on the road to success.

Nitrogen vacancy fluorescence from a submicron diamond cluster levitated in a linear quadrupole ion trap

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