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ANP100 positioners for photoluminescence measurements in magnetic fields up to 28 T

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The attocube systems positioners ANPxyz100/LT have been used in a setup for optical measurements in LHe temperature and magnetic fields up to 28 T at the Grenoble High Magnetic Field Laboratory. In the setup laser excitation is delivered using a single-mode fiber and is focused onto the sample with two microlenses. A multimode fiber is used for photoluminescence (PL) collection. The estimated laser spot size was 20 µm and its position over the sample is controlled by an attocube systems ANPxyz100/LT set of positioners. The setup has been placed in a non-magnetic steel tube of 32 mm diameter and immersed in liquid Helium. The 1.8 m long tube can be mounted in a Helium cryostat. The cryostat can fit in the bore of a resistive magnet in the Grenoble High Magnetic Field Laboratory, which supplies continuous magnetic field up to 28 T. The PL spectra were dispersed by a 1 m double grating monochromator and focused onto a CCD. Both, Ar+ laser and Ti:Sapphire tunable lasers were used for the measurements. A general view of the setup is shown in Figure 1. One can see the fixed fibers and lenses (middle part of the Figure) and the sample, which is mounted onto the set of attocube systems x, y, and z piezostages (right-hand side of the Figure). During measurements the setup is immersed in liquid Helium and subject to magnetic fields up to 28 T.

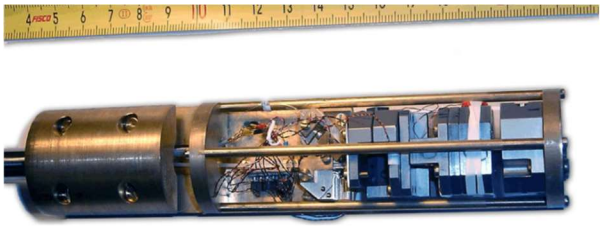

Figure 1: *General view of the setup.*

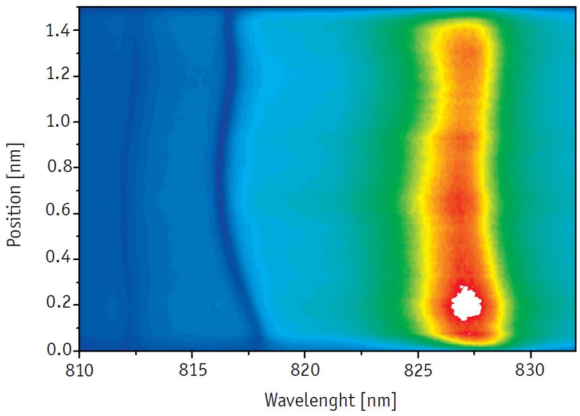

Figure 2: *Scanning photoluminescence spectrum of a bar-like sample of epitaxial GaAs.*

Properties of the setup can be presented in an example measurement of the near-edge photoluminescence of an epitaxial layer of GaAs (see Figure 2) excited with laser light of 796 nm. A broad PL band around 825 nm is due to the recombination of bound excitons in GaAs. The relatively long wavelength of the excitation light permits its penetration into the bulk GaAs, which results in the seen broadening of the spectrum. Dips in the spectra around 816 nm result from a reabsorption of the light emitted from bulk GaAs by free excitons in the epitaxial layer of GaAs. Its dependence on the actual position on the sample reflects most likely a strain distribution in the epitaxial layer.

The setup has also been successfully used for single-dot spectroscopy measurements in high magnetic fields. The number of semiconductor self-assembled quantum dots is limited by mesa-patterning of the sample (submicron sized mesas are used for measurements on a single quantum dot). An example of the obtained results is presented in Figure 3. A series of emission lines due to recombination of excitons in a single quantum dot can be followed in magnetic fields up to 26 T. A diamagnetic shift as well as the splitting of lines can be seen in the trace of the emission lines versus magnetic field. The emission lines are due to excitons involving the carriers from the ground state ("s"-shell) of a single quantum dot.

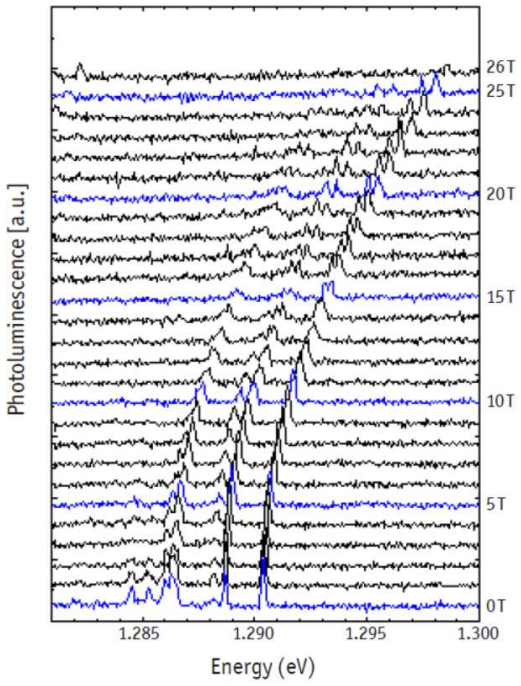

Figure 3: *Single-dot spectroscopy of a single quantum dot in high magnetic field of up to 26 T.*

References

[1] A. Babinski, S. Awirothananon, J. Lapointe, Z. Wasilewski, S. Raymond, and M. Potemski, Physica E 26, 190–193 (2005).