Fundamental properties of (Ga,Mn)As: evolution from paramagnetic through superparamagnetic to ferromagnetic phase

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The high-spectral-resolution optical studies of the energy gap evolution, supplemented with electronic, magnetic and structural characterization, have shown that the modification of the GaAs valence band caused by Mn incorporation occurs already for a very low Mn content, much lower than that required to support ferromagnetic spin–spin coupling in (Ga,Mn)As [1]. The combined low-temperature magnetic and optical studies indicate that the paramagnetic↔ferromagnetic transformation in *p*-type (Ga,Mn)As takes place without imposing changes of the unitary character of the valence band with the Fermi level located therein**(Fig.1).** The whole process is rooted in the nanoscale fluctuations of the local (hole) density of states and the formation of a superparamagnetic-like state.

The advanced optical investigations of the described above set of the GaAs/(Ga,Mn)As heterostructures with the combined photoreflectance and spectroscopic ellipsometry methods in a wide range of wavelengths will be presented. Comparing the evolution of the optical transitions at E0 with those at E1 and E1+ Δ1 optical-transition spectral areas allows for better understanding the band structure modification in (Ga,Mn)As with increasing Mn concentration.

Reference

1. L. Gluba, **O. Yastrubchak,** JZ. Domagala, R.Jakiela, T.Andrearczyk, J.Żuk, T. Wosinski, J. Sadowski, and M. Sawicki, Band structure evolution and the origin of magnetism in (Ga,Mn)As: From paramagnetic through superparamagnetic to ferromagnetic phase, Physical Review B 97 (11), 115201 Published: 2018

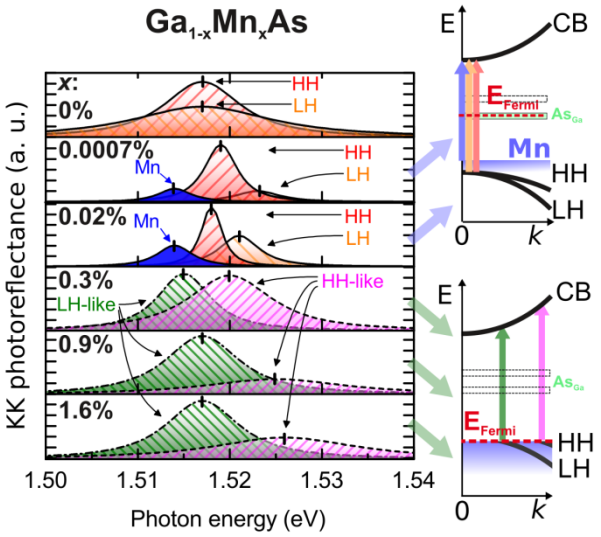

Figure 1. Results of KK integration of the LT-PR spectra fitted components. For x = 0% the two, HH and LH related, features can be observed. An addition of Mn to GaAs changes the spectra by appearance of the low energy feature (solid filled one, marked with "Mn") together with the energy separation of the rest of the features. Turning the conductivity, from n to p-type, for x ≥ 0.3%, modifies the character of the spectra into two broadened features instead of three.