The Esaki diode with the p-type part made from (Ga,Mn)As proved to be a very efficient device for spin injection into semiconductors [1]. Moreover, it was successfully used to probe the subbands of the valence band in (Ga,Mn)As due to tunneling anisotropic magnetoresistance effect (TAMR) [2]. Such studies contribute to the hot discussion on the structure of the valence band and impurity band in (Ga,Mn)As [3, 4].

Here we report the results of TAMR studies in a set of (Ga,Mn)As / GaAs Esaki diodes with a wide range of Mn content. Thin 50 nm (Ga,Mn)As layers were grown on a 50 nm thick n+ GaAs film on the n-GaAs substrate. Five wafers were grown with Mn content varying from x=1.5% to 8.5%. Square mesa structures with dimensions from 50 µm to 300 µm were patterned by means of optical lithography and wet etching. Three complementary techniques were applied to study the structural, magnetic and transport properties of the samples: X-ray diffraction, SQUID magnetometry and measurements of current as a function of bias applied to the junction, magnetic field and temperature.

The magnetometric characterization revealed two types of magnetic behaviour of (Ga,Mn)As: (1) paramagnetic for $x \leq 1.9\%$ Mn content and (2) ferromagnetic for $x \geq 4.1\%$, with an in-plane easy axis. I(V) curves for the diodes showed typical backward-diode-behaviour at the reverse bias, and for all the diodes the curves were very similar. In this case electrons tunnel to unoccupied conduction band states in GaAs through a thin barrier. For forward bias, i.e. tunneling of electrons to (Ga,Mn)As states, the I(V) curves showed biexponential behaviour with no traces of negative differential resistance but clearly seen random telegraph noise. It is not evident, what the two ranges with different exponents of I(V) correspond to. However, for ferromagnetic samples in both ranges a strong dependence of the current on the value of the magnetic field was observed. The most interesting fact is that for the $x = 4.1\%$ sample this effect is isotropic, whereas for higher Mn content sample it is strongly anisotropic. This effect will be discussed in terms of contribution of different valence band subbands to the tunneling process. The presented preliminary results are promising with regard to our ongoing hydrostatic pressure investigations concerning the relation between valence band and hypothetic Mn impurity band of (Ga,Mn)As.

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