Achieving electrical connections to (sub-)micrometer size vertical transport structures based on GaN

K. Kalbarczyk[1], M. Foltyn[1], R. Adhikari[2], A. Bonanni[2], T. Dietl[1,3,4], and M. Sawicki[1]

[1]*Institute of Physics, Polish Academy of Sciences, Warszawa, Poland*
[2]*Institut für Halbleiter - und Festkörperphysik, Johannes Kepler University, Linz, Austria*
[3] *International Research Centre MagTop, Warszawa, Poland*
[4]*WPI-Advanced Institute for Materials Research, Tohoku University, Sendai, Japan*

In order to verify experimentally theoretical prediction about large spin filtering capabilities of thin ferromagnetic (Ga,Mn)N layers, devices as GaN:Si/(Ga,Mn)N/GaN:Si were grown on sapphire substrates for vertical transport studies [1]. It was found that both 200 x 200 and 60 x 60 µm mesas, despite exhibiting some increasing on lowering temperature non-ohmic behavior [1], were generally shorted by highly conductive sapphire-GaN misfit-related threading dislocations (TDD) [2]. In order to mitigate the detrimental influence of the TDD on the vertical transport through (Ga,Mn)N magnetic barriers a reduction of the mesas area to such a degree is required that, statistically, at least one-in-four devices should be TDD free. For a typical aerial density of TDD approaching 10^{10} cm^{-2} structures smaller than 0.5 µm are envisaged. However, to electrically connect such small devices with the experimental set up, special conductive suspended structures - the air bridges – have to be fabricated, as sketched in Fig. 1a.

Here, in order to achieve this goal, that is to elaborate the whole technological process, the first 12 µm long and 200 nm narrow gold air bridges with 6-7 µm pad sizes have been successfully fabricated by electron beam aided lithography and electrically tested. We find them to be both mechanically and electrically robust with electrical resistance of about 50 Ω. This technological effort is the first step towards elaboration of fully operational sub-micrometer devices.

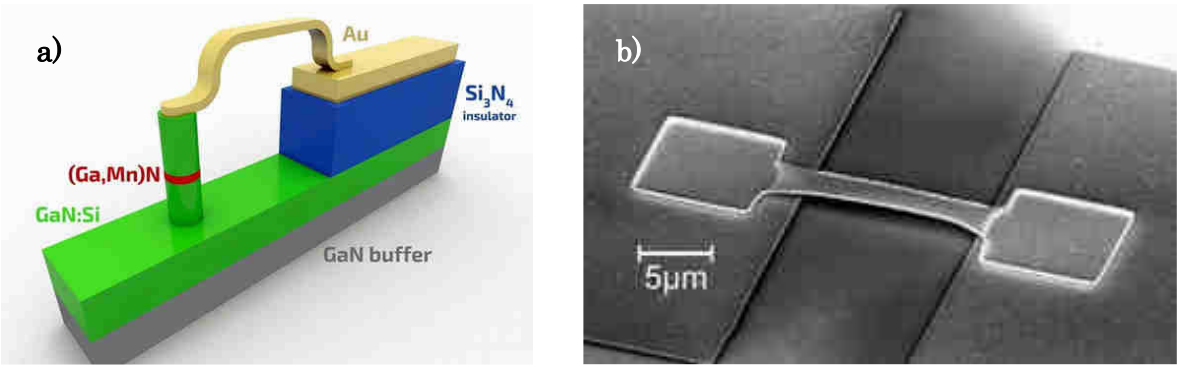

Fig. 1: **a).** Schematic representation of the (sub-)micro-meter size vertical mesa connected to a contact pad by an "air-bridge"; **b).** SEM photo of the gold "air bridge" connector.

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