# Electrical characteristics of vertical-geometry Schottky junction to ferromagnetic insulator (Ga,Mn)N heteroepitaxially grown on sapphire


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In order to establish a metal-to-(Ga,Mn)N Schottky barrier height and the ideality factor $\eta$ a vertical transport device has been fabricated from heteroepitaxially grown (Ga,Mn)N on commercially available low threading dislocation density GaN:Si template. The investigated junction has been defined lithographically by an opening in the additional insulating dielectric $Al_2O_3$ layer grown by atomic layer deposition on top of (Ga,Mn)N to facilitate electrical bonding, as schematically depicted in the Figure. Two terminal resistance observed in the range of tens of MΩ indicates that a nearly conductive-dislocation-free electrical properties are achieved. The analysis of the forward bias I-V characteristics performed in the frame of the thermionic emission model yields Ti-(Ga,Mn)N Schottky barrier height $\Phi_B \cong 0.6$ V at room temperature, a value close to the Schottky barrier heights reported for other technologically important transition metals to GaN. Also $\Phi_B$ temperature dependence for $150 < T < 300$ K corresponds very well to the other literature data. However, the large magnitudes of the ideality factor, $\eta > 1.5$ in the whole studied $T$-range, though not so uncommon in nitride Schottky junctions, point to a sizable blocking of the current in the structure. It still remains to be verified whether it is due to the presence of the insulating (Ga,Mn)N, or some other factors which reduce the effective area of the junction are in force.

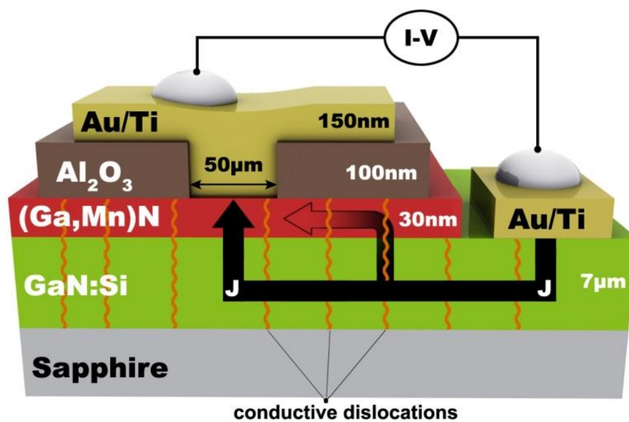


**Figure.** Schematic representation of the narrow vertical device containing an insulating (Ga,Mn)N layer grown on a low threading dislocation density GaN:Si template using molecular beam epitaxy. The effective dimensions of the junction conductive channel are set by the opening in the additional insulating $Al_2O_3$ layer. The latter serves simultaneously as an insulating support for a contact pad much larger than the Au/Ti-(Ga,Mn)N junction.


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