Ultra low resistance, non-alloyed ohmic contacts to n-InGaAs

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Very low resistance metal-semiconductor contacts are crucial for the performance of transistors in THz bandwidths. A contact resistivity of less than $1\text{x}10^{-8}\ \Omega$ -cm^2 is required for III-V HBTs and FETs for having simultaneous 1.5 THz ft and fmax [1], [2]. Here we report the ultra-low specific contact resistivity (ρ_c) of non-alloyed in-situ Molybdenum Ohmic contacts to n-type $In_{0.53}Ga_{0.47}As$, lattice matched to InP. The $In_{0.53}Ga_{0.47}As$ films were grown by solid source Molecular Beam Epitaxy (MBE) system on semi-insulating InP (100) substrates. For the in-situ contacts, 20 nm of Molybdenum was deposited in an electron beam deposition system connected to MBE under ultra high vacuum. The active carrier concentrations were confirmed by Hall measurements. The samples were then processed into Transmission Line Model (TLM) structures for contact resistance measurement using standard photolithography and dry etch process. The lowest specific contact resistivity achieved for in-situ contacts was $(3.1 \pm 2.5)\ \text{x}10^{-9}\ \Omega$ -cm^2 for samples with $5\text{x}10^{19}$ cm^{-3} active carrier concentrations, with repeatability. This contact resistivity is very low as compared to $(1.3 \pm 0.4)\ \text{x}10^{-8}\ \Omega$ -cm^2 reported by Singisetti et al [3] for in-situ Mo contacts on n-InGaAs. This drop in contact resistivity can be attributed to higher number of active carriers than $3.5\text{x}10^{19}$ cm^{-3} reported in [3]. Fig. 1 plots the measured resistance vs. the pad spacing in the TLM structures for in-situ molybdenum contacts. The contacts were found to remain stable, maintaining a low contact resistivity on annealing at 300 ^{o}C and 400 ^{o}C for 1 minute duration. These data indicate that the in-situ Mo gives ultra low Ohmic contacts, probably due to the absolute lack of oxygen at the metal semiconductor interface.

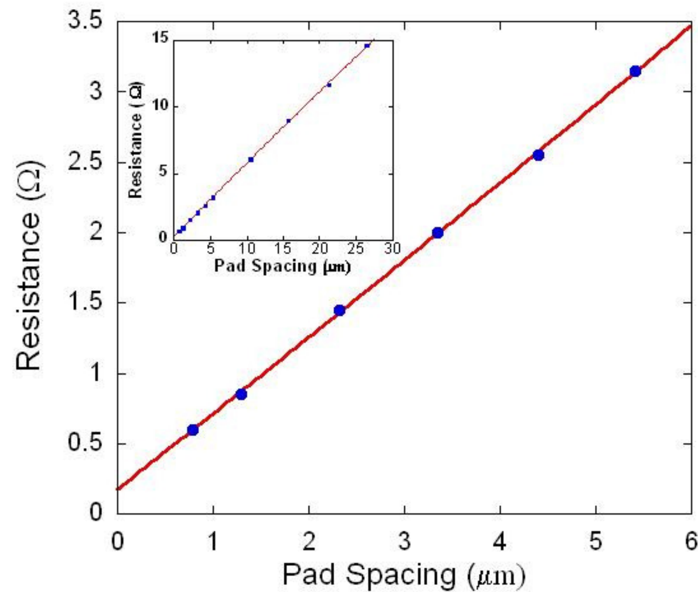

Fig. 1: Measured TLM resistance as a function of pad spacing for in-situ Molybdenum ohmic contacts on n-InGaAs. The inset plots measured TLM resistance vs. pad spacing ranging from 0.8 μm to 27 μm.

1. *M. J. W. Rodwell et al., Int. Journal of High Speed Electronics and Systems. 11,159 (2001).*
2. *M. J. W. Rodwell et al., Proceedings, Compound Semiconductor Integrated Circuit Symposium, 2008*
3. *Singisetti et al., Applied Physics Letters, 93, 1 (2008*)