USE OF Ti/W/Cu, Ti/Co/Cu AND Ti/Mo/Cu MULTI-LAYER METALS As SCHOTTKY METALS FOR GaAs SCHOTTKY DIODES

C. S. LEE, E.Y. CHANG , J. J. HE,
Department of Materials Science and Engineering, National Chiao Tung University, HsinChu, Taiwan, ROC.

The Ti/Pt/Au Schottky contact on n-GaAs is the most widely used Schottky structure in the fabrication of metal semiconductor field effect transistors(MESFET), high electron mobility transistors(HEMT), and Schottky diodes[1,2]. In the present study, the thick overcoat gold layer was replaced with copper. Pt layer was replaced with the transition metals such as W, Co and Mo. The choice of the refractory metals was based on their resistivity and the capability as the anti-diffusion barrier. The resistivity of W, Co and Mo metals were much lower than Pt, their thickness play a major role in determining the gate metallization resistance of a FET for a specified total thickness of the Schottky structure.

New Schottky structures with copper metal and refractory diffusion barrier metal (Ti/W/Cu, Ti/Co/Cu, Ti/Mo/Cu) for GaAs Schottky diodes were evaluated. The Schottky metals chosen in this study demonstrated excellent electrical characteristics as the Schottky metal for GaAs diodes. The multi-layer metals were deposited through a metallic mask on the surface of n-GaAs. The GaAs surface were cleaned with $H_2O+H_3PO_4$ solution before the metal films deposition. Then the Schottky metal was applied by RF sputtering. The Schottky metals were annealed at 150℃ -300℃ after deposition. Figure 1 shows the typical forward I-V characteristics of these Schottky structures after annealing at 200℃ for 2-min. The ideality factor and Schottky barrier height are 1.08/0.78eV, 1.07/0.71eV and 1.06/0.76eV for Ti/W/Cu, Ti/Co/Cu and Ti/Mo/Cu structure respectively after annealing at 150℃ for 2 minutes. The results are comparable with the typical Ti/Pt/Au Schottky diode which has an ideality factor close to 1.07. From the XRD results(Fig 2), the Ti/W/Cu and Ti/Mo/Cu Schottky structure are thermally stable after annealing up to 400℃ for 30 minutes; Ti/Mo/Cu Schottky structure is thermally stable up to 300℃ for 30min. These results show that the new Schottky structures have excellent electrical characteristics compare to the traditional Ti/Pt/Au structure and can be used as the Schottky metals for GaAs devices. The results also paves the way for the front side Cu metallization of GaAs devices in the future.

Reference

1. Sehgal,B.K, Gulati,R,Naik,A.A,Materials Science and Engineering:B, Vol 48,p229(1997).
2. Sehgal,B.K,B.Bhattacharya,Seema Vinayak,Ramesh Gulati, Thin Solid Film,Vol 330,p146(1998).

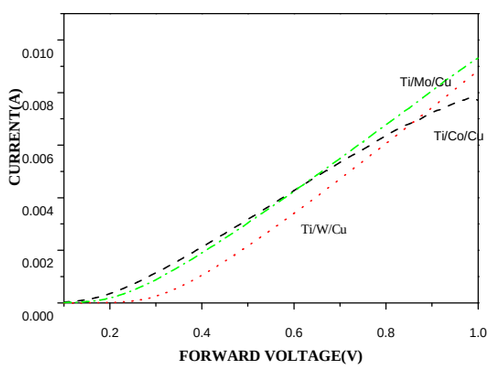

Fig 1. Typical forward I-V characteristics of Ti/W/Cu, Ti/Mo/Cu and Ti/Co/Cu structure after annealing at 200℃ for 2-min.

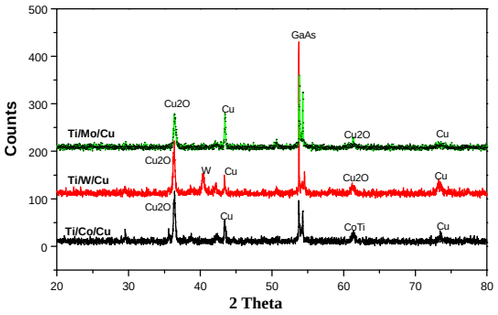

Fig 2. XRD patterns of Ti/W/Cu, Ti/Mo/Cu and Ti/Co/Cu structure after annealing at 400℃ for 30-min.

Table 1. The ideality factor n and barrier height Φ(eV) of the Schottky diode before and after annealing.

	As dep.		150℃		200℃		300℃	
	n	Φ	n	φ	n	φ	n	φ
Ti/W/Cu	1.15	0.78	1.08	0.78	1.05	0.92	1.06	0.83
Ti/Co/Cu	1.11	0.7	1.07	0.71	1.05	0.73	1.07	0.73
Ti/Mo/Cu	1.11	0.77	1.06	0.76	1.05	0.69	1.04	0.74
Ti/Pt/Au	1.11	0.76	1.07	0.77	1.09	0.77	1.07	0.77