Anomal behaviour related to boron concentration of W-B-N thin films on Si substrate for magnetic devices

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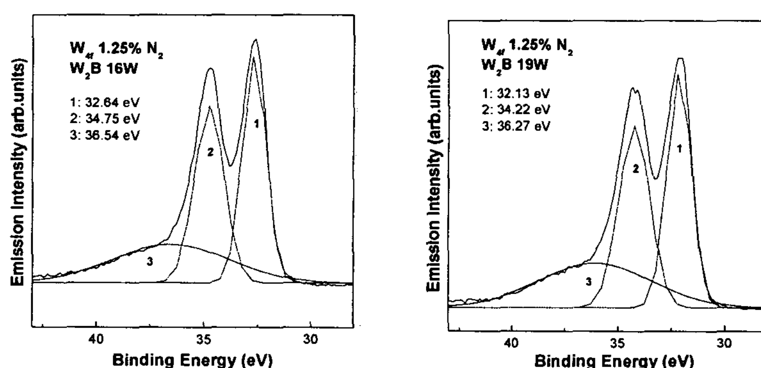
The electrical and the structural behaviors of tungsten boron nitride (W-B-N) thin films[1] were studied to investigate the effects of boron and nitrogen in the 1000 Å W-B-N thin films. The W-B-N thin films were deposited by using the RF magnetron sputtering method.The substrates were p-doped (100) Si wafers with a resistivity of 5-6 Ω-cm. Prior to the sputtering, the substrates were degreased, spin-dried, and loaded into the reactor. The sputtering targets were a W target with a purity of 99.99% and a W_2B target with a purity of 99.95%. Before the deposition, Ar pre-sputtering was performed to remove the native oxide layer on the target. The flow rates of mass-flow controllers. The total pressure of (N_2 + Ar) was varied in the range of 0 – 30%. The RF power density of W was fixed at W/cm^2 whereas that of W_2B was varied from 0.4 to 0.7 W/cm^2. The impurities of the W-B-N thin films provided a stuffing effect that was very effective for preventing interdiffusion between the inconnection metals or magnetic thin films and the silicon during the subsequent high temperature annealing process. Although the boron concentrations increase linearly but the resistivity is deelply decreased at certain point and then re-increased. These anomal behaviours are very surprising because boron is stuffing effect. Thus I think that the boron concentration increases, then the resistivity also be increasing. But the result is different. This singular point give us more information about ternary compound diffusion barrier. In order to improve the diffusion barrier characteristics, it is possible to control the ratios of nitrogen and boron concentrations. That's why, we investigate the binding energy of W-B-N thin diffusion barrier at various W_2B target power. These experiments show that the binding energy of W_{4f} 7/2 states[2] is related to the resistivity.



References

[1] Y.T. Kim, C.W. Lee, and D.J. Kim, Appl. Phys. Lett., **72(12)**, 1507 (1998).
[2] C.W. Lee, Y.T. Kim, and S-K Min, Appl. Phys. Lett. **62(25)**, 3312 (1993).