Properties of Very Thin Tungsten Film Deposited using Inductively Coupled Plasma Assisted Sputtering

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As the device width is reduced under 10 nm due to the high integration of semiconductor devices, resistivity of metal interconnection is greatly increased due to the decrease of the device width. Cu has a low resistivity and conductivity, and it is the most commonly used as a metal interconnection. However, there are shortcomings in using Cu as metal interconnection. Resistivity of Cu increases sharply due to surface scattering as the line width is decreased due to the long electron mean free path (EMFP) of 39 nm, and the reliability of Cu is degraded as device operating temperatures and current densities are increased with each technology node. Since W has a smaller EMFP than Cu, it could have lower resistivity than Cu as it goes to small dimension. Furthermore, because W has very high melting temperature, there is a possibility that Cu could be replaced with W for metal interconnection. In this study, ICP assisted sputtering of W has been investigated to lower the resistivity of very thin W film. An internal-type coil antenna has been used for a high ionization property of plasma, and DC sputter system has been used for deposited W thin film. By using high energetic tungsten ion, we could get dense structure of W thin film at low temperature. Due to the increased plasma density near the magnetron surface, the addition of ICP power decreased the magnetron voltage and increased the magnetron current. When the characteristics of W thin film deposited with and without ICP assistance were investigated, the decrease of the W thin film resistivity could be confirmed. Using the XRD, the decrease of β peak which is A-15 structure and the increase of α peak which is bcc structure at both room temperature and 673K were observed with ICP-assisted sputtering. It means ICP assistance influence the decrease of the W thin film resistivity. Also, the change of O in the W thin film affecting the resistivity was analyzed by XPS. As aresult, the feasibility of tungsten deposited by ICP assisted sputtering as a next-generation metal interconnect material was investigated.

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