Investigation of Thermal Stability and Delivery of Cobalt Amidinates and Novel Cobalt Formamidinates for Metallic Cobalt by ALD/CVD

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There is growing interest in cobalt metal and cobalt silicate films in logic and memory devices, especially for Co capping layer application. It is now well established that the Co capping layer formed on the Cu interconnect (as opposed to the low-k dielectric) significantly improves the top interface of the Cu lines for electromigration (EM) resistance. Co capping layers offer the advantage of substantially lower resistance and physical and electrical compatibilities with Si so that it could be potentially used in CMOS for source and drain contact metals and other Si nanowire devices. The Co precursor selection for CVD and ALD is primarily based on good thermal stability, high reactivity, the ease of deposition of Co, and precursor delivery technique including Direct Liquid Injection process (DLI).

For CVD and ALD of cobalt, various sources such as Co2(CO)8, (tert-butyl acetylene) Co(CO)4, (allyl)Co(CO)3, and Co(THD)2 were used before with limited success. Most recently, a cobalt amide precursor has been investigated. In this study, we report the successful use of cobalt amide precursor (i.e., Co-AMD) along with several novel cobalt formamidinate precursors (i.e., Co-FAMD). The results evidently show that Co-AMD as well as Co-FAMD offer significant advantages over conventional precursors in terms of their higher vapor pressures and greater thermal stabilities.

The physical properties of these sources, such as solubility, volatility, thermal stability, chemical compatibility, and viscosity will be discussed. Results showing the high purity of the sources based on ICP-MS and FT-NMR analyses will be reported, along with the characterization of the thermal stabilities with supporting TGA, ARC, and FT-NMR analysis. Preliminary ALD and CVD results of Co metal deposition using the new sources will be discussed, using Vapor-Draw process.

**References**
4. a) H.-B.-R. Lee, G.H. Gu, C.G. Park, H. Kim, 216th ECS meeting, October 4-9, 2009, Vienna, Austria

**Conclusions**
- New cobalt sources (liquid Co-1, Co-2, Co-3, Co-4, Co-5, and Co-6) were successfully developed as the choices of Co precursors for deposition of Co and CoSi2 thin-films by ALD and CVD.
- Those Cobalt precursors were also designed to be Co sources for direct liquid injection delivery for ALD and CVD.
- The new cobalt precursors were successfully demonstrated to grow metallic Co and CoSi2 films at lower temperature, particularly for liquid Co-1.