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CVD OF PURE COPPER FILMS FROM AMIDINATE PRECURSOR

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Chemical vapour deposition of aluminium-copper-iron intermetallic compounds implies the use of compatible precursors for the involved elements. The component metals in this system have different chemical properties which govern the choice of the right precursors. Specifications for such precursors include oxygen-free ligands and similar deposition conditions. This presentation reports on the use of a novel copper amidinate compound Copper(I)*N,N'*-diisopropyl-acetamidinate $[Cu(i\text{-}Pr\text{-}Me\text{-}AMD)]_2$ ([1]) to produce copper films in conventional low pressure CVD using hydrogen as reducing gas-reagent. This is relatively air-stable substance which has been tentatively tested in the literature as ALD precursor[2].

Saturated vapour pressure of [Cu(i-Pr-Me-AMD)] was first measured by static method. Then, copper films were deposited on steel, silicon and oxidized silicon substrates in the temperature range 200°C – 300°C and total pressure of 10 Torr. Their composition, morphology, conductivity and growth rate have been investigated by electron probe microanalysis (EPMA), grazing incidence X-ray diffraction (GIXRD) and scanning electron microscopy (SEM). Films are composed of polycrystalline copper metal without carbon and nitrogen impurities. Typical XRD pattern of the copper films is presented in fig. 2. The deposition rate has been evaluated directly by weight difference and indirectly by EPMA in the whole temperature range. The obtained Arrhenius plot is presented in fig. 3. Linear fit in the range 200-240 °C gives a slope ~65 kJ/mol which is remarkably close to hydrogen dissociation energy on copper surface[2]. The copper films were shiny metallic and specular in reflection on well polished substrates and conductive with respect to dielectric substrates. CVD copper has denser nucleation and smoother surface morphology on metallic substrates. The grains size increases gradually with deposition temperature from ~20 nm at 200 °C to ~200 nm at 300 °C (fig. 4, 5).

Thus, good storage stability in combination with the determined processing window and the characteristics of the deposited films make $[Cu(i\text{-}Pr\text{-}AMD)]_2$ a promising CVD precursor for the MOCVD of Al and Cu-containing intermetallic alloy films.

References

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Fig.1: Structural representation of the precursor.

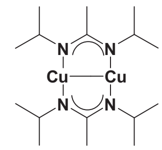

Fig. 2: XRD analysis of the film deposited at 300°C: 1) Si substrate, 2) steel substrate.

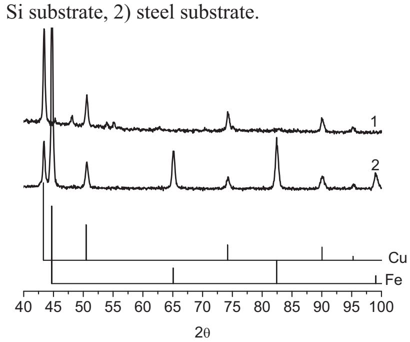

Fig.3 The growth rate on steel substrate.

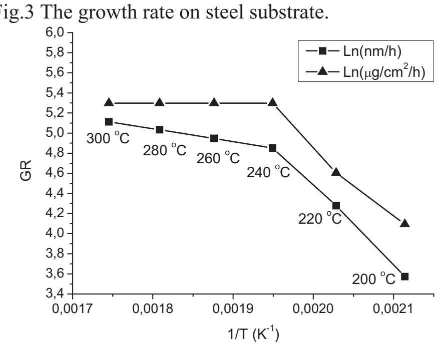

Fig. 4: The micrograph of copper films CVD at 240°C.

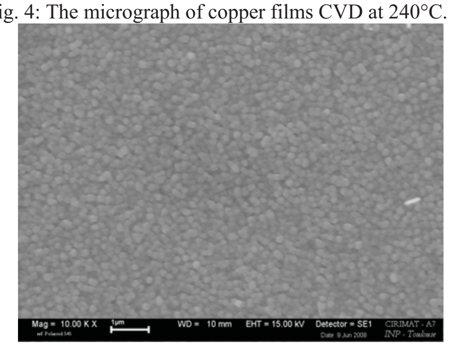

Fig. 5: The micrograph of copper films CVD at 300°C.