ABSTRACT

Among all the deposition techniques, Chemical Vapour Deposition (CVD) has important advantages that it is a non-line of sight process. While Physical Vapour Deposition (PVD) delivers atoms or small groups of atoms to the substrate surface, CVD carries molecules. These molecules can adsorb/desorb or diffuse on the evolving film many times before they decompose and further film growth. Consequently, more uniform films are formed and conformal coverage is more likely with CVD.

Chemical Vapour Deposition of films and coatings involve the chemical reactions of gaseous reactants on or near the vicinity of a heated substrate surface. This atomistic deposition method can provide highly pure materials with structural control at atomic or nanometer scale level. Moreover, it can produce single layer, multilayer, composite; nano structured, and functionally graded coating materials with well-controlled dimension and unique structure at low processing temperatures.

The main objective of the present study was to build an indigenous CVD system and to deposit and characterize copper on aluminium using copper acetylacetonate as the precursor and using argon and nitrogen as carrier gases separately.

The design of a CVD system involves knowledge on basic physical, chemical and engineering sciences. A CVD system consisting of carrier gas,
precursor, vapourisation, a deposition reactor and by-product disposal systems was designed, fabricated and assembled. Commercially available argon or nitrogen were purified and allowed to pass through the hot precursor vapouriser in order to carry them to the reactor chamber. All the gas-carrying lines were maintained at relatively high temperature. The reactor is housed within the coils of a 30 KW/500KHz induction heater, which is used to heat the clean substrate on which the deposition is to be carried out. The reaction chamber is connected to vacuum system through a liquid nitrogen trap. The actual diagrams of chemical processing lines, vapour carrying lines, vapourisor, reaction chamber, base plate details of the CVD reactor, vacuum and exhaust lines are also presented. The operating sequences of the CVD system are shown as a flow chart. The details of all the components involved in assembling of CVD are discussed.

Metalloorganic compounds suitable as precursors for most of main-group and transition metal elements are now available from a number of commercial sources. When not available or when stringent requirements are imposed, precursors are readily prepared in laboratories for immediate use in vapor depositions. The starting compound for any of recently available copper (II) organometallic precursor, Copper (II) acetylacetonate was prepared in the laboratory by chemical method. The structure and purity were ascertained by employing FTIR and XRD methods and the thermal properties were determined from DTA/TG and DSC methods. The preparation and characterisation of the precursor compound are discussed.
The CVD system assembled has been successfully employed to deposit copper on aluminium. This results in this report fill the gap of literature on employing copper acetylacetonate as precursor and using argon and nitrogen as carrier gases in the CVD of copper and also over aluminium substrates. The deposition rate of copper using copper acetylacetnoate and using hydrogen, argon and nitrogen are in the following order

\[ \text{Hydrogen}^* > \text{Argon} > \text{Nitrogen} \]

in surface reactions activated temperature region and the deposition rates all almost equal at the mass transfer controlled regime. The resistivity measurements and XRD pattern confirms that the deposition process is slow when nitrogen is employed as carrier gas. The SEM and AFM results that the processes precede by random nucleation of copper initially and around each nucleus, clusters are formed and finally all these clusters join to form a continuous copper film.