Thin films

Lecture (5) (part 1)

Dip-coating

is an industrial coating process which is used, for example, to manufacture bulk products such as coated fabrics and specialized coatings for example in the biomedical field. Dip coating is also commonly used in academic research, where many chemical and nanomaterial engineering research projects use the dip coating technique to create thin-film coatings.

As a popular alternative to Spin coating, dip-coating methods are frequently employed to produce thin films from sol-gel precursors for research purposes, where it is generally used for applying films onto flat or cylindrical substrates.

By this technique, the material from which the film is produced is put into solution, and then the substrate is progressively dipped into and is extracted from the solution at a controlled rate (Figure 1). After the solvent evaporates, a thin and homogeneous film is produced. Many factors contribute to determining the final state of the dip coating of a thin film. A large variety of repeatable dip coated film structures and thicknesses can be fabricated by controlling many factors: functionality of the initial substrate surface, submersion time, withdrawal speed, number of dipping cycles, solution composition, concentration and temperature, number of solutions in each dipping sequence, and environment humidity. The thickness of the film is generally bigger than that prepared by spin-coating with the same solutions. The dip coating technique can give uniform, high quality films even on bulky, complex shapes. Dip-coating was successfully used, for example, to

prepare sol-gel-derived Al_2O_3 films on γ-TiAl-based alloys, porous TiO_2 films and SrO-SiO_2-TiO_2 on NiTi, and so on.

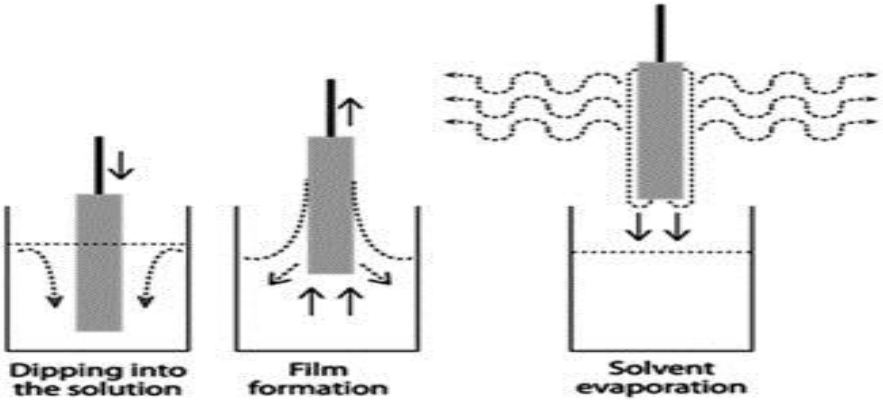

Figure 1. Schematics of a dip-coating process.

The dip-coating process can be separated into five stages.

1. Immersion: The substrate is immersed in the solution of the coating material at a constant speed.
2. Start-up: The substrate has remained inside the solution for a while and is starting to be pulled up.
3. Deposition: The thin layer deposits itself on the substrate while it is pulled up. The withdrawing is carried out at a constant speed to avoid any jitters. The speed determines the thickness of the coating .
4. Drainage: Excess liquid will drain from the surface.
5. Evaporation: The solvent evaporates from the liquid, forming the thin layer. For volatile solvents, such as alcohols, evaporation starts already during the deposition and drainage steps.

In the continuous process, the steps are carried out directly after each other.