3. High-throughput chemical vapour deposition platform

A lot of effort is directed to the preparation of metal oxide materials with enhanced optical and electrical properties. High-throughput methodologies are a powerful tool to study the mechanism of variation of oxides and dopants and the relation to optical/electrical properties. This way the range of dopant addition, the combination of oxide type and dopant type, the possibility of depositing mixed oxides, etc, can be investigated in a fast, inexpensive way. This is in contrast with the classical approach where varying several process parameters is a time-consuming and expensive task.

Chemical Vapor Deposition, CVD, is a widely extended method for deposition of high purity, fine grained, impervious, hard coatings. In addition, film thickness can be controlled by varying the processing time, thus allowing the deposition of ultra-thin films while maintaining excellent coating characteristics. High-Throughput Chemical Vapor Deposition, HTCVD, allows superb flexibility for fast deposition of coatings. It is highly suitable for time-consuming and trial-and-error processes especially due to the increasing complexity of modern materials.

This project focuses on the study of metal oxides using high-throughput CVD operating in atmospheric pressure. Operating in atmospheric pressure allows for the scalability in a continuous processing line. The high-throughput CVD workflow allows the development of new coatings on a wide range of substrates, for instance metallic and glass substrates.

3.1. Platform Design

The high-throughput CVD equipment was designed to allow homogeneous deposition of films in a fast way with a wide range of operational flexibility. To serve this purpose the nozzle reactor was optimized to do depositions in discrete fields. The samples are positioned in a sample holder that allows the placement of 24 samples (figure 3.1).

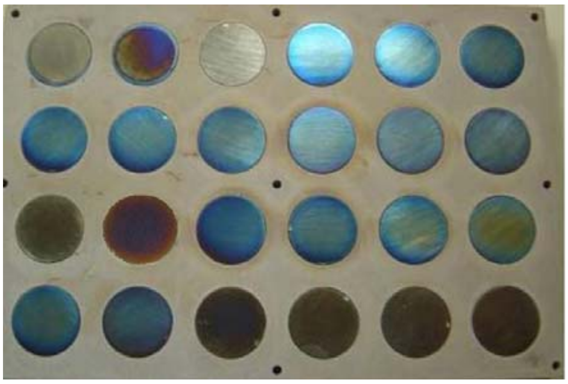

Figure 3.1: Sample holder containing 24 TiO_2 samples deposited on a stainless steel substrate.

Radiative heating using an infra-red diode laser, combined with a dynamic scanning device was chosen for the HT-CVD workflow. High heating rates for both discrete glass and steel samples are possible allowing a good heating homogeneity between 200 and 700°C.

The system can handle up to three precursors, which can be in a form of a liquid or a solid. In the case of liquid precursors the delivery to the reactor is assisted by a flow of nitrogen carrier gas. Additionally, four reactive or un-reactive gases can be used.

The samples are positioned in the sample holder and loaded into the processing chamber through the load-unload chamber (figure 3.2). In addition to the possibility of working with three different precursors and four gases, the temperature of the bubbler, nozzle, lines and deposition as well as the time of deposition can be controlled in an automated way.

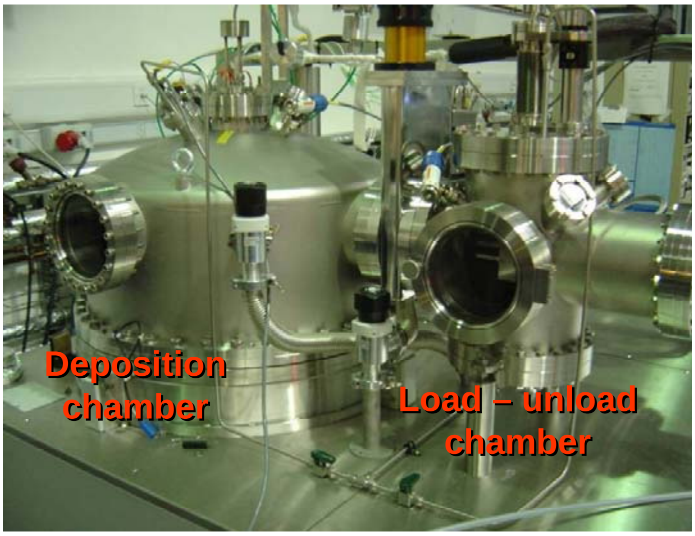

Figure 3.2: Sample holder containing 24 TiO_2 samples deposited on a stainless steel substrate.

3.2. Software

The operation of the high-throughput CVD workflow is fully supported by advanced software tools, allowing to efficiently explore the multidimensional parameter space associated with coating development.

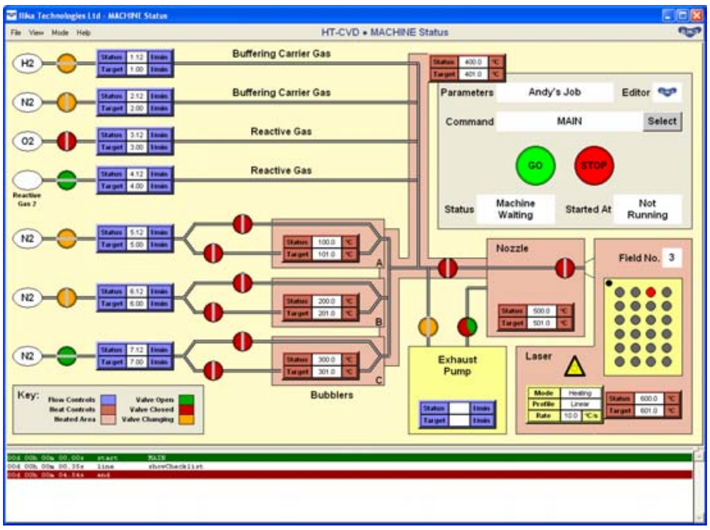

Figure 3.3: Screenshot of control software.