

STATE OF THE ART OF PLASMA CHEMICAL SYNTHESIS OF HOMOGENEOUS AND
HETEROGENEOUS PRODUCTS

P. Fauchais - J.M. Baronnet
Laboratoire de Thermodynamique - U.E.R. des Sciences
Université de Limoges - 123 rue A. Thomas - 87100 Limoges France

Since 1960 many studies have been devoted to physical and chemical transformations in plasmas. Unfortunately at the beginning the unsuitability of the theoretical concepts used for the understanding of the phenomena, associated with a rather poor perception of the economical considerations led, in 65-70, to a lack of large research programs in United States. However in the years 72-74 a better understanding of the phenomena in the plasma and the situation arising from the oil crisis have renewed the interest in plasma chemistry. The progress that has been done in measurement techniques and data acquisition (cross sections and kinetics constants of the excited states, diffusion coefficients, thermodynamic and transport properties of different mixtures, velocity and temperature measurement of particles in a plasma jet) and for the modelisation, allowed an important reduction of the energetic costs of reactions. This reduction coincided with a tremendous increase of the cost of oil and a rather good evaluation of the economical cost of some well selected plasma chemical or physical process have allowed some industrial development. Concurrently the industrial search for new processes using electrical energy has developed research in the field of plasma chemistry.

We do not propose to make an exhaustive overview on plasma chemistry, but only to try to describe some new techniques of measurement and modelisation that have allowed progress to be made and to see from a few examples what are their applications.

- First we will deal with the problem of measurement of the temperature and population of excited species by emission, absorption and mass spectroscopy and by laser excitation. We will also examine models taking into account kinetics, diffusion and mixing of reactants and also the catalysis problems
- Secondly we will examine the temperature and velocity measurement of particles in a plasma jet and also the modelisation of plasma-particle heat and mass transfer
- The examples we have chosen to illustrate the preceding considerations are :
 - . synthesis in the gaseous phase of NO, HCN and C₂H₂
 - . thin film Si and Si₃N₄ deposition
 - . plasma spraying and plasma spheroidisation
 - . plasma vaporisation and condensation
 - . extractive metallurgy

- We will also look at the economic aspects of some processes and try to see what are the future industrial applications of plasma chemistry.