The role of sensor technology is obvious in improvement and optimization of many industrial processes. The sensor films, which are considered the core of chemical sensors, have the capability to detect the presence and concentration of a specific chemical substance. Such sensor films achieve selectivity by detecting the interaction of the specific chemical substance with the sensor material through selective binding, adsorption and permeation of analyte. This research focuses on development and verification of a comprehensive mathematical model of mixed metal oxide thin film growth using spray pyrolysis method. An experimental setup is used to synthesize mixed metal oxide films on a heated substrate. The films are analyzed using a variety of characterization tools. The results are used to validate the mathematical model and optimize the synthesis technique. There are three main stages to achieve this goal: 1) Development of a CFD model of atomizing multi-component solution to predict droplet characteristics in flight. 2) Development of a mathematical model of multi-phase transport and chemical reaction phenomena in a single droplet to predict the deposition of thin film. 3) Characterization of the processed films for morphology and chemical composition to validate the models as well as investigate the influence of process parameters on the structural characteristics of mixed metal oxide films. The structural characteristics are investigated of nano structured thin films comprising of ZnO, SnO2, ZnO+In2O3 and SnO2+In2O3 composites. The model adequately predicts the size distribution and film thickness when the nanocrystals are well-structured at the controlled temperature and concentration.