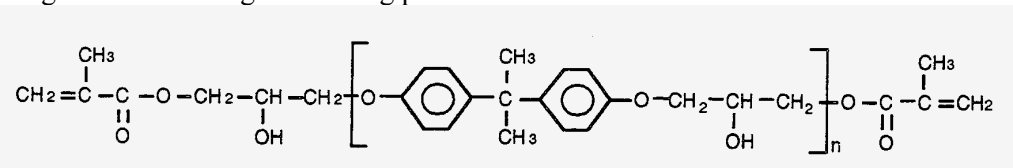
RADIOFREQUENCY (27.12 MHz) ACTIVATION OF THE RADICAL CURING REACTION OF UNSATURATED POLYESTERS OF EPOXY-ACRYLIC TYPE IN STYRENE SOLUTION

Albert Gourdenne

Ecole Nationale Supérieure des Arts Chimiques et Technologiques
118, route de Narbonne, 31077 Toulouse Cedex 4, France

The liquid unsaturated polyester of epoxy-acrylic type - styrene mixture used is a model system for the quantitative study of the interactions of the thermosetting resins with radiofrequencies or RF (27.12 MHz) during their electromagnetic curing process.



Chemical structure of the unsaturated polyester of epoxy - acrylic type (n= 2.79)

The crosslinking of the mixture, which leads to final glassy networks, is performed through the radical copolymerization between the methacrylate functions in terminal position of the polyester and the vinyl group of styrene (~40%). Dibenzoyl peroxide (~1%) is added as radical initiator. The curing of the prepolymer (polyester + styrene + initiator) works at constant number of relaxing species, which are carbonyls and hydroxyls. Consequently, the dielectric loss in the organic matter depends on the mobility of such entities, that it is to say on the viscosity of the polyester solution, which increases as the extent of the reaction of copolymerization. Moreover, the data, extracted from dielectric relaxation spectra drawn in our laboratory, show that the absorption of the carbonyls, which absorb in the microwave region, between 3 and 5 GHz, is shifted towards low frequencies, including RF (27.12 MHz), when the viscosity grows or when the copolymerization is in progress. This last tendency is in favour of the RF processing in comparison with that carried out under microwaves working at 2.45 GHz, since the decoupling between microwaves and the polyester chains starts as soon as the copolymerization becomes significant, while, at the same time, the coupling carbonyls - RF is more and more facilitated. As for the hydroxyls, which appear under a broad peak located around 400 MHz, the same tendency is observed. In brief, the coupling between the prepolymeric material and RF is much more efficient than in the case of microwaves, because the dielectric loss is much higher. This is why radiofrequencies are preferred to microwaves in the polymer industry. The samples to be polymerized with parallelepiped shape (260 ml) are positioned between two parallel steel plates put at an alternating electrical potential oscillating at 27.12 MHz. The study of the time dependence of the temperature T of the chemical matter and of the dielectric loss P at given potential V_0, or of the potential V at given dielectric loss P_0, leads to curves, which provide information about the kinetics of the curing and on the structural changes, which can occur inside the polymeric system. Of course, the interpretation of all curves is made from the knowledge of the series of all reactions, which happen when the classical thermal activation is applied inside an oven. The determination of the glassy transition temperature of the networks is used as a parameter of valuation of the efficiency of the electromagnetic process of activation, which allows its later optimization. Moreover, it shows that there is no specific effect of the RF energy on the optimized final structure, since its glassy transition temperature is quasi-identical to that of the structure obtained when a classical thermal heating is used for the activation of the processing.