Work stages: Activity 2

Milestone: 4

Milestone name: Curing kinetic models for the selected resins with high microwave absorption properties

Microwave processing can be used over a broad range of polymers and products, including thermoset and thermoplastic resins, rubber and composites. Many polymers contain groups that form strong dipoles (e.g., epoxy, hydroxyl, amino, cyanate, etc.). Thus, epoxy resins efficiently couple microwaves and have very high maximum values of dielectric losses $\varepsilon'' \geq 1$ enough for their utilization in microwave assisted pultrusion processes. To increase the microwave absorption properties of other polymers: polyester, vinyl ester with maximum values of dielectric losses in diapason of $\varepsilon'' \approx 0.3 - 0.4$, different additives (susceptors) with a high dipolar moment are used. The effect of heating depends on their size, geometry, concentration and electric resistance of the additive, as well as on their dispersion and distribution in the polymeric matrix. All the heating promoter additives are subdivided in three groups:

- metallic fillers (metals, metal oxides, ferroelectrics),
- organic additives (glycols, phthalates, cyanates, amines),
- inorganic and transparent additives.

In general, for the microwave assisted pultrusion could be used the same resins like in conventional pultrusion processes described in activity 1 (milestone 1). If epoxy resins have high microwave absorption properties and can be used directly in advanced microwave assisted pultrusion processes, polyester and vinyl ester resins should be improved adding susceptors increasing their dielectric loss factor. It is necessary to note that most additives are inert for the curing kinetic and, if some new susceptors will demonstrate in future the behavior of exothermic reaction with heat generation, their influence on the curing kinetic will be negligible due to very small content (0.5-3.0 %) in the utilized resins. Thus, the kinetic analysis is carried out for the resins without susceptors. Their influence is taking into account in time of determination of the dielectric loss factor for composite material (resin, susceptor, fibers) used in the pultruded profile.

Three types of resins for pultrusion profiles have been chosen:

- epoxy resin RIMR 135,
- epoxy resin EPIDIAN,
- polyester resin POLRES 305 BV.

The methodology for the building of curing kinetic models developed in the previous activity 1 (milestone 1) has been applied in the present study to describe the curing behaviour of examined resins. To define their curing kinetic parameters, results of DSC scans performed by Mettler Toledo on samples heated from 20°C to 250°C at rates of 2, 5, 10 °C/min have been utilised. Using these experimental results, different curing kinetic models for the selected resins have been built and their accuracy have been estimated.