Abstract of PhD thesis: Ceramizable elastomer composites

The aim of the thesis was studying properties of elastomer composites which undergo ceramization process under fire and/or exposition to high temperature.

Ceramizable polymer composites became commercially available few years ago. Firstly, as polysiloxane composites, destined for production of cable covers, which can protect copper wire against flames, heat and mechanical stress, able to maintain functioning of electrical circuit in fire, providing electric power for important equipment like fire sprinklers, alarm systems, lamps indicating emergency evacuation routes, elevators, etc. A few years later, first ceramizable composites based on organic polymer matrix were described in scientific literature. Nowadays, many industrial and university groups work for development of ceramizable polymer composites.

Ceramization process is a new way in improvement of flame protection and thermal stability of polymer materials, based on creation of strong non-flammable ceramic barrier between gas and solid phase in fire. This layer decreases diffusion of heat and oxygen from gas to solid phase in order to prevent thermal degradation of polymer matrix and catalytic oxidative reactions, as well as diffusion of fuel and toxic or corrosive products of polymer degradation to burning zone, reducing amount of harmful products being emitted in smoke.

Thesis is composed of three major parts:

- Studies on properties of commercially available silicone rubber-based composites.
- Development of new kinds of silicone rubber-based ceramizable composites and studying of their properties.
- Development of new kinds of organic rubber-based ceramizable composites and studying of their properties.

First part of the thesis describes processability, mechanical properties, tribological properties and wear of commercial silicone rubber-based composites, destined for cable covers.

Second part of the thesis contains results of research on ceramizable silicone rubber-based composites reinforced with mineral, polyamide or carbon fibers as well as composites containing organically modified montmorillonite clays, different type of refractory fillers, or boron oxide (III) applied as a fluxing agent. In this part, properties of ceramizable composites of polymer matrices, based on ethylene-propylene-diene rubber (EPDM), chloroprene rubber

(CR), acrylonitrille-butadiene rubber (NBR) and styrene-butadiene rubber (SBR) are also presented.

To characterize properties of prepared composites, following analytical techniques were applied:

- Kinetic of vulcanization and rheological properties, to describe processability of composite mixes before curing.
- Thermogravimetry (TG-DSC), oxygen index value tests (OI), to describe thermal properties and flame retardancy of composites.
- Hardness, tear strength, tensile strength and wear resistance, to describe mechanical properties of composites.
- Tribological tests of composites against stainless steel realized in different configuration of friction couple.
- Scanning electron microscopy (SEM-EDS), tree point flexural tests, and porosimetry, to describe morphology and mechanical properties of ceramic phase being created under high temperature.

Results of the studies show, that increase of mechanical properties of silicone composites is possible using reinforcing fibers or creation of nano-porous ceramic phase after ceramization due to application of montmorillonite modified with ammonium salt. Studies on composites based on organic elastomers demonstrate, that the best properties exhibit systems containing SBR and CR.