PROPERTIES OF CERAMIZABLE STYRENE-BUTADIENE RUBBER COMPOSITES CONTAINING GRAPHITE

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Ceramization of elastomer composites is a process, the influence of high temperature or fire action changing structure of the materials. During this process a ceramic structure, is created on the surface of material which protects rest of it from further degradation [1].

In order to make the ceramization process of elastomer composites happened, it is necessary to add to the mixture a special filler, which has to characterize itself by relatively low softening temperature of about 375-500°C [2]. Such a filler, so called fluxing agent, is intended to connected particles of other fillers before all polymer matrix will be degraded [fig.1]. So, the composites at room temperature behave like rubber materials. Thanks creating on their surface ceramic structure [fig. 2], they are able to protect for example copper wire from melting under fire conditions, even up to 2 hours [3].

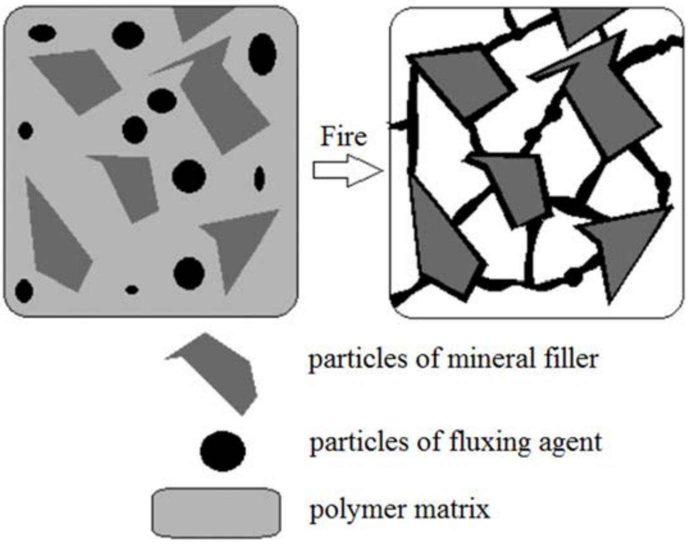

Fig. 1. Mechanism of ceramization process.

Statistical reports indicates that, around the World on average 7 million fires are recorded yearly, in which around 70 thousands people die [4]. According to caution statistics it is estimated that, fires bring monetary losses in amount of circa 1% of GNP of all countries. Ceramizable composites could prevent or at least limit the effects of most fires. With electrical systems capable of preserving the integrity of electrical or water systems, it is much simpler and more effective to conduct rescue operations. Sprinkler systems or installations facilitating the movement of the crowd during the evacuation could be work longer. It would be possible rescue the elderly and the disabled with well-functioning fireproof elevators. In addition, the statistical possibility of fire occurrence would be much lower, which is extremely important in places, where people's live depends on machines reliability, such as planes, boats or drilling platforms.

High amount of filler negatively affects the viscosity and flow during polymer composition processing. It happens because elastic, easily deformable and flowing rubber contributes only in

20-30 wt.% of whole material. Mineral fillers, which are the majority of the composites, generate large friction forces between particles when moving against each other. One way to decrease these forces is to use additional substances, which are working like lubricant - plasticizers.

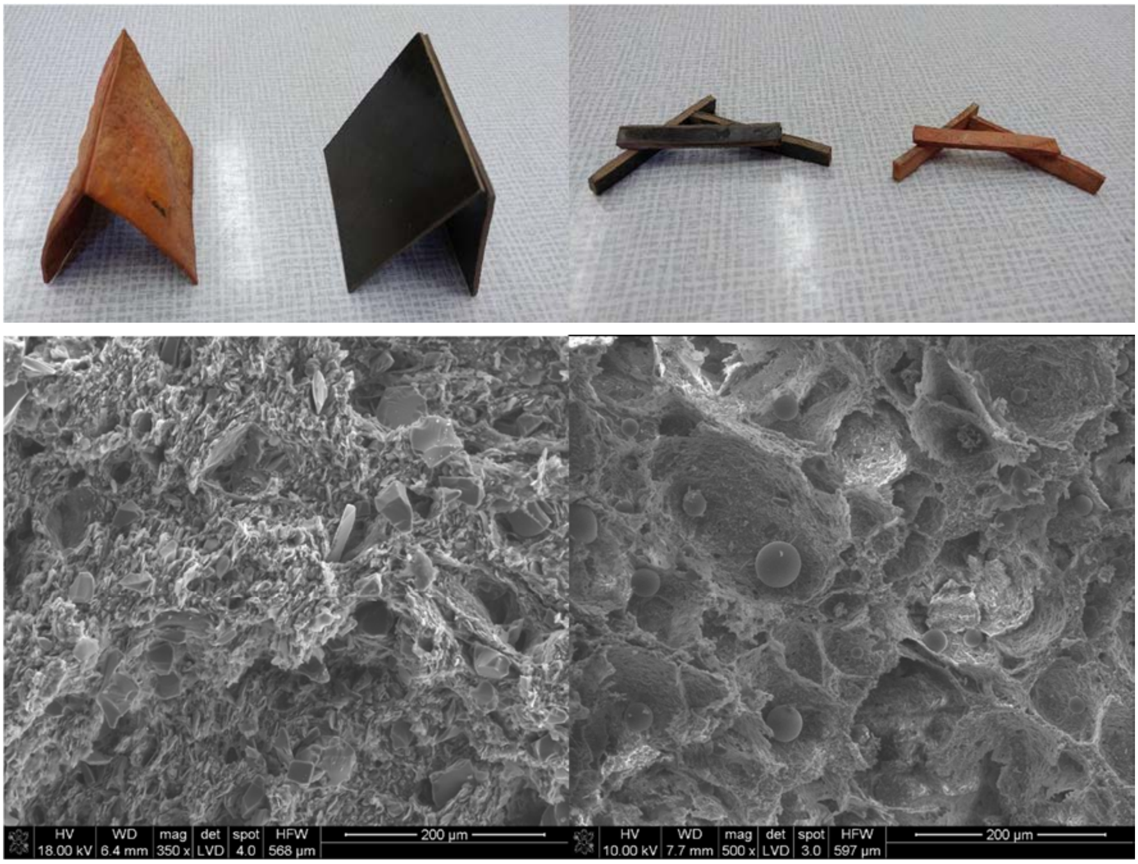

Fig. 2. The higher photographs show how is changing the structure of ceramizable composites macroscopically (darker samples - before ceramization, lighter samples - after ceramization). The lower photos from the scanning electron microscope illustrating how the micro-morphology of the ceramizable composites changes (on the left before ceramization, on the right after ceramization).

In this work as lubricant was used graphite. For the researches were made ceramizable composites containing different amount of graphite to test how are changing rheological and processing properties (fig. 3). Also important was to keep both mechanical and thermal properties (fig. 4) at a satisfactory level.

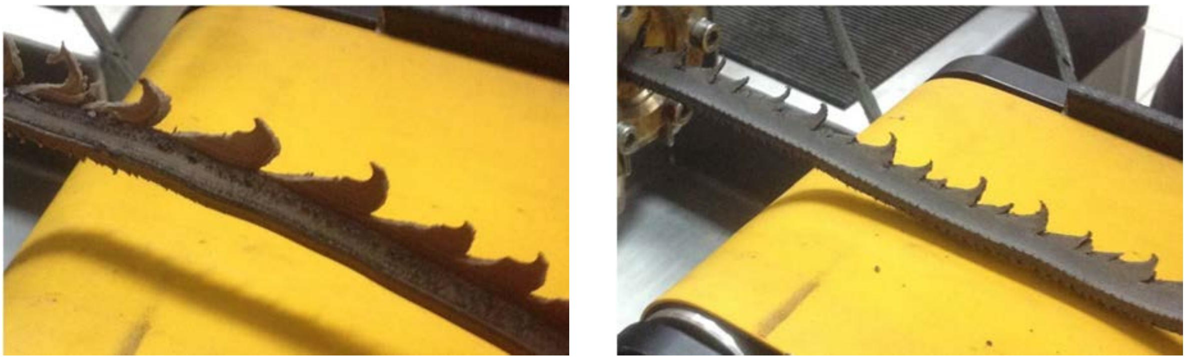

Fig. 3. Ceramizable composites after extrusion (left – reference, right – containing graphite)

Composite containing graphite after extrusion presents itself far from ideal, but a significant improvement to compare to reference sample is visible.

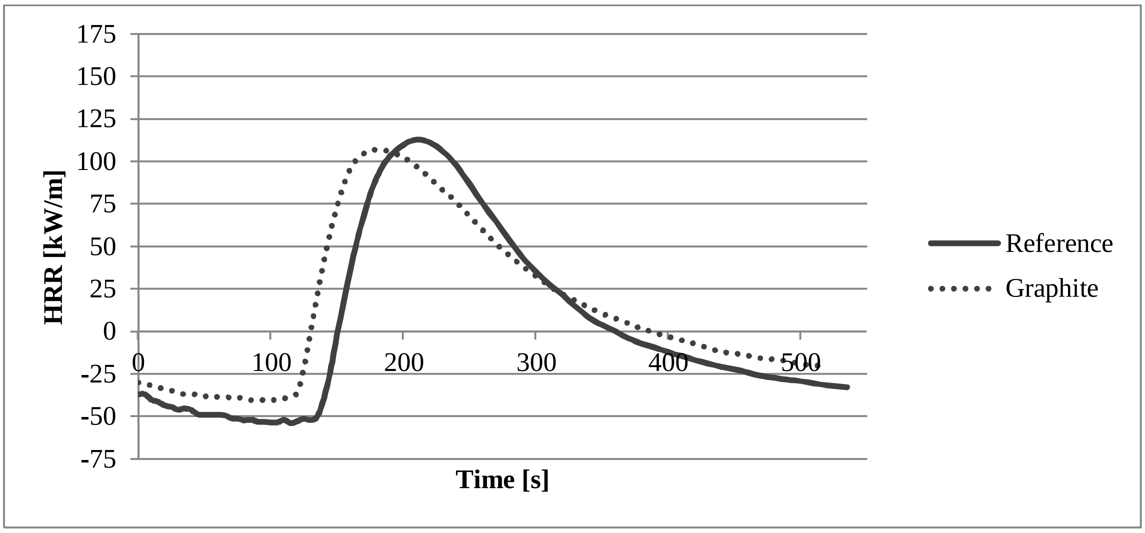

Fig. 4. Heat release rate from cone calorimetry for reference and containing graphite ceramizable composites

Heat releasing is at the same level in both composites. Composites containing graphite is starting burn earlier, because is burning graphite located on the samples surface. After that, the ceramic phase is crated and heat release rate is dropping.

The ceramization process is purely physical (also referred to as passive), which means it has an advantage over classic methods of flame retardation of polymer composites, because as a consequence there are not created or created much less dangerous (corrosive and toxic) products of thermal decomposition of polymer matrix and applied chemicals antipersins that can pose a greater threat to human health and life than fire and high temperature.

References:

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