Impact of Cellulose Physical-Mechanical Treatment on Elastomeric Composite Properties

First, the study analysed the effect of pressing time on the **residual moisture content** of the filler sample (Fig. 1). This determination allows not only to determine the residual moisture in the sample but also the moisture removed by the pressing process when compared to the moisture content of the unpressed sample. The moisture content of the sample can be viewed from two perspectives, the first is the effect on the plasma process, where it is proven that higher filler moisture supports plasma etching, reduces surface oxidation and the second is the negative effect on elastomer composites, where higher filler moisture content can cause defects in the vulcanizate, such as air bubbles. From the results of the residual moisture determination, 4 minutes was chosen as the most suitable pressing time due to the lowest moisture content in the sample, especially to limit the negative effect on elastomer composite vulcanizates.

The lowest value of **hardness** (Fig. 2) was achieved by the unfilled composite. In composite without filler content, the hardness is directly dependent on the density of the network formed during vulcanization. By adding a filler to the CEL-st composite, the hardness value increased. The filler placed in the inter-network spaces reduces the flexibility of the composite vulcanizate and increases the resistance to hardness tester indenter penetration. An interesting finding is that the hardness value of the composite did not change significantly by treating the filler by pressing (CEL-p). The process of pressing the filler therefore does not affect the hardness value. In the composite CEL-pp a decrease in the value occurred compared to other composites (CEL-st, CEL-p). This decrease was also visible in the case of maximum torque. The reason is the plasma effect on the filler fibres and their shortening due to stress during mixing and pressing. Shorter fibres cause greater flexibility of the matrix in which crosslinking bonds are not so limited.

The **tensile strength** values (Fig. 3) are also influenced by the filler content in the composite. The highest value was achieved by the unfilled composite, where the tensile strength value is provided only by the formed crosslinking bond, so the tensile strength value corresponds to the strength of the bonds formed during the vulcanization process. By adding a filler to the composite, the tensile strength values rapidly decreased. The CEL-st composite achieved the lowest value (the influence of the tensile strength result is a combination of the influence of the filler moisture on the vulcanization process - affecting the activity of the accelerator and its effectiveness in the process of forming crosslinks). The highest value was achieved by the CEL-p composite, in which it can be assumed that the reduced moisture caused a higher matrix crosslinking value, which increased the tensile strength value. With the plasma-treated filler (CEL-pp), the tensile strength value decreased slightly again. Shortening the length of the filler fibres by plasma caused an increase in possible stress concentrators during loading, as the number of fibres was higher. In the case of incorporating the filler directly into the vulcanization network, or cross-linked with the matrix, the effect would be reversed.

The highest **elongation at break** (Fig. 3) value was achieved by the unfilled composite. It has the highest matrix content, which is flexible, but due to the absence of filler, crosslinking bonds are not limited under tensile stress. Adding filler to the composite reduced the elongation at break values. Crosslinking bonds under tensile stress are limited in movement by the filler. Most bio-fillers function as stress concentrators in the matrix and thus reduce not only the elongation at break of the composite but also, the tensile strength. This is different in the case of bio-fillers that are directly incorporated into the vulcanization network or crosslinked with the matrix, which can be achieved through various modifications.

- CONCLUSION -

In conclusion, it can be stated that the filler treatment by pressing has a significant effect not only on the moisture content in the filler but also on the rheological properties and vulcanization characteristics.

The positive effect of the pressing treatment is also visible on the tensile properties. The pressing of the filler also shortened the time needed to dose the filler to composite during the mixing process. The treatment of the filler by the plasma process partially limited the positive effects of the filler pressing, but the composite with this filler treatment still achieved better properties than the composite with the filler without treatment.