Silane modification of wood flour and its application into a polymer matrix

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ABSTRACT

Wood flour, obtained during wood processing, is often used as a filler in polymer composites. However, its hydrophobicity and low adhesion to polymer matrices can limit its effectiveness in these applications. To improve these properties, wood flour was modified in three different ways using (3-aminopropyl)triethoxysilane (APTES). The modified forms of wood flour were then incorporated into a polymer matrix and analyzed. The aim of this study was to evaluate the impact of these modifications on the vulcanization, rheological, and mechanical properties of polymer composites. The effect of the silanization reaction of the modified wood flour forms was also observed. The results indicate that the modification of wood flour with APTES significantly affects the interaction between the filler and the polymer matrix, which leads to the improvement of selected properties of the composites. Comparing different modification methods allowed for the identification of the most effective way to treat wood flour, optimally enhancing the properties of the polymer matrix. This study provides valuable information for the development of environmentally composite materials based on wood flour. Due to its versatility and environmental benefits, wood flour represents a valuable material with potential for a wide range of applications.

MATERIALS

The biowaste - wood flour (W) derives from the production of wood pellets of the company ECPU, s.r.o. was used for research. The wood flour sample was dried due to the elimination of the excess moisture and was prepared particle sizes between 25-40 μm.

Fig. 1 Laboratory screening machine

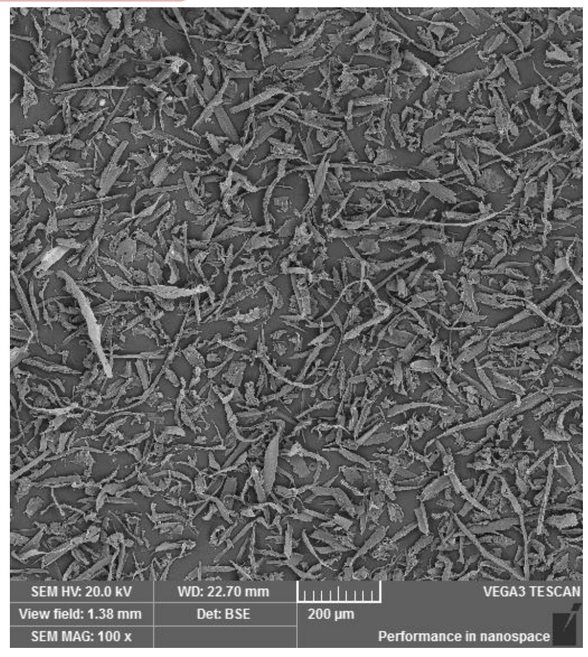

Fig. 2 Analysis of wood flour shape by scanning electron microscope

Tab. 1 The elemental composition of wood flour (W)

SAMPLES	Element, %				
	C	**Si**	**Ca**	**S**	K
W	99.377	0.203	0.149	0.077	0.075

SILANE MODIFICATION

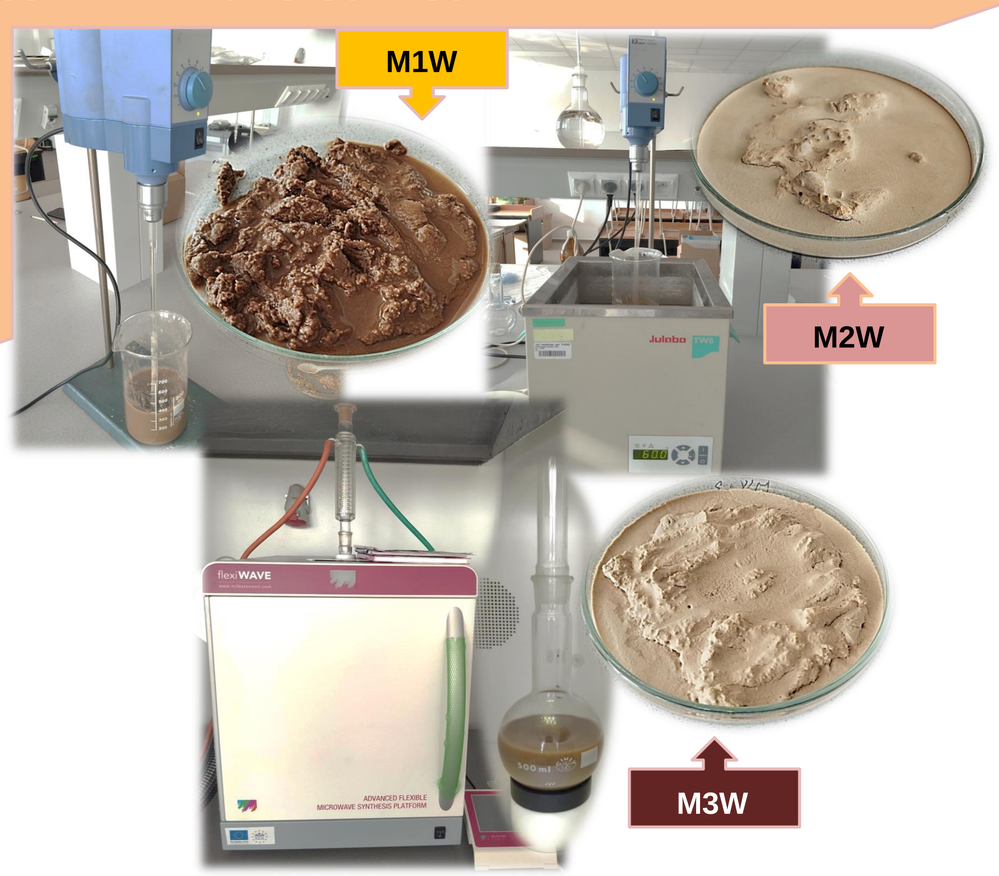

Fig. 3 Silane modification of wood flour

PREPARATION OF SAMPLES

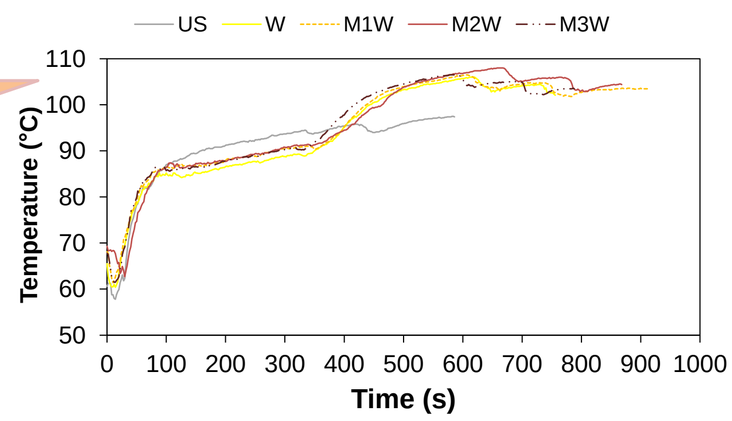

Fig. 4 Mixing process of polymer blends

Five rubber blends were prepared using a Brabender mixer. The mixing was carried out in a single-step process. The modified forms of wood flour were then incorporated into a polymer matrix and compared with blend filled with unmodiefied form of wood flour.

RESULTS

Tab. 2 Rheometric characteristics of polymer samples

Samples	M_L (dN.m)	M_H (dN.m)	$\Delta M = (M_H - M_L)$ (dN.m)	T_{s2} (min.)	T_{90} (min.)	CRI (min.$^{-1}$)	αf
US	1.31	18.59	17.28	3.07	6.00	34.13	-
W	1.25	27.00	25.75	3.53	5.66	46.95	2.45
M1W	1.18	29.90	25.72	3.45	5.66	45.25	2.45
M2W	1.28	27.38	26.10	3.46	5.60	45.45	2.55
M3W	1.27	27.07	25.80	3.39	5.43	49.02	2.45

RESULTS

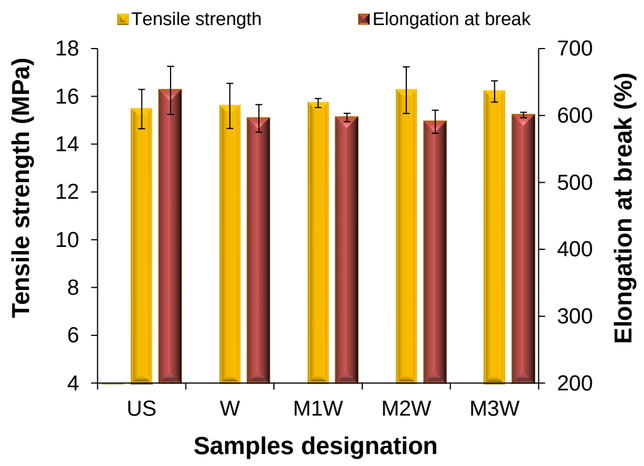

Fig. 5 Mechanical properties of polymer samples

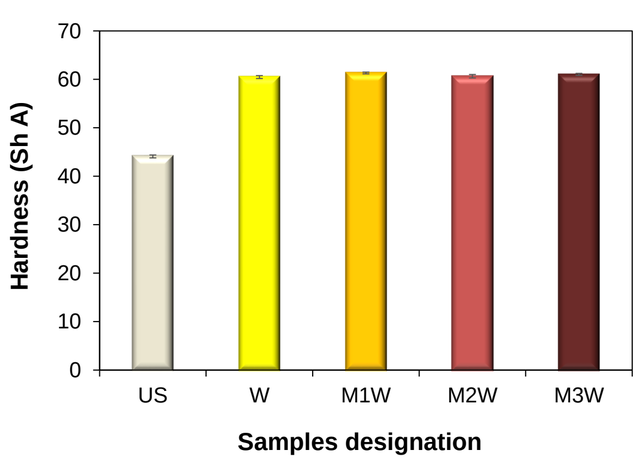

Fig. 6 Hardness of polymer samples

CONCLUSION

The results indicate that the modification of wood flour with APTES affects the interaction between the filler and the polymer matrix, which leads to the improvement of selected properties of the composites. Comparing different modification methods allowed for the identification of the most effective way to modified wood flour. The superior properties observed in sample M2W confirm the second modification approach as the optimal method for modifying wood flour.

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