

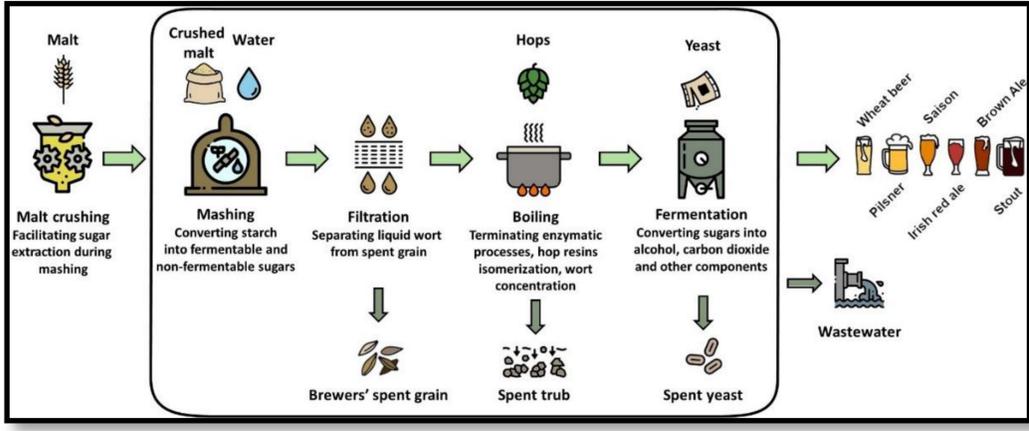
Sustainable upcycling of solid brewery wastes into disposable products



Aleksander Hejna, Mateusz Barczewski

Institute of Materials Technology, Poznan University of Technology, Piotrowo 3, 61-138 Poznań, Poland
email: aleksander.hejna@put.poznan.pl

BREWERY WASTES – GENERAL INFORMATION

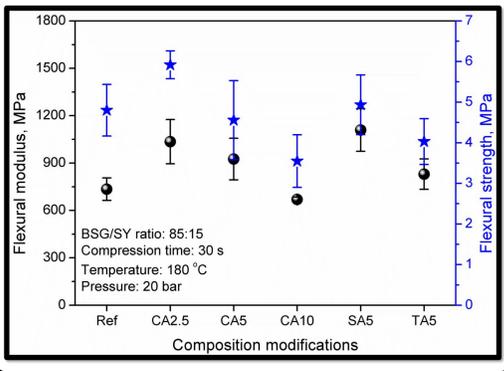
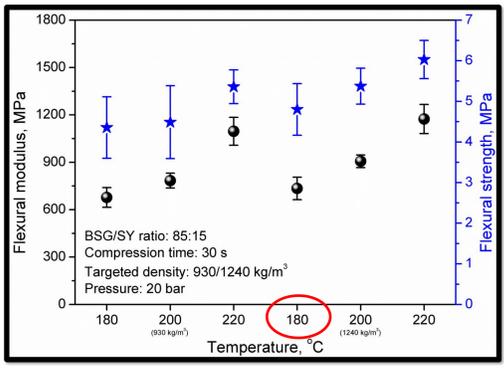
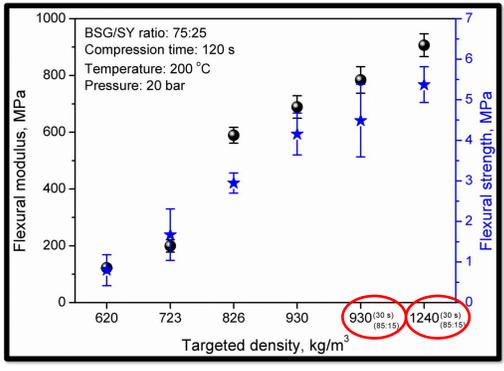
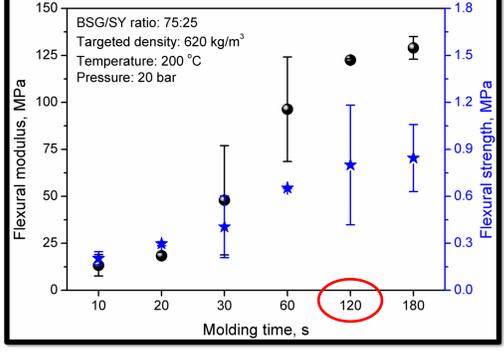


- Beer – the most popular alcoholic beverage worldwide, production volume 1.91–1.97 billion hectoliters annually, inclusive and hardly limited geographically.
- Main solid by-products: brewers' spent grain (BSG) (~85%), spent yeast (SY) (~15%), spent trub/hops (<1%), currently somewhat underutilized, as they are mainly distributed to the local farmers and further used as animal feed, which primarily reduces the utilization costs.
- So far, utilization of BSG and SY without fractionation and complex treatments/purification has been overlooked.

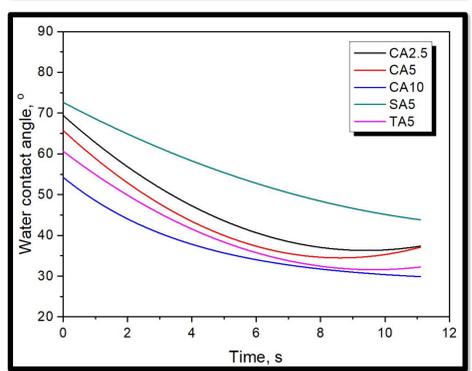
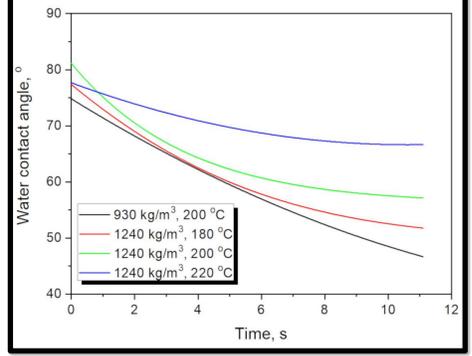
MATERIALS & MANUFACTURING

BSG and BSY have been obtained from the local breweries. Citric acid (CA), succinic acid (SA), and L-(+)-tartaric acid (TA) have been applied as additional crosslinking agents. Peanut, hazelnut, sesame, linseed, sunflower, and walnut oils have been used as coatings for prepared materials. After homogenization, materials have been compression molded with varying process parameters (time, temperature, targeted density).

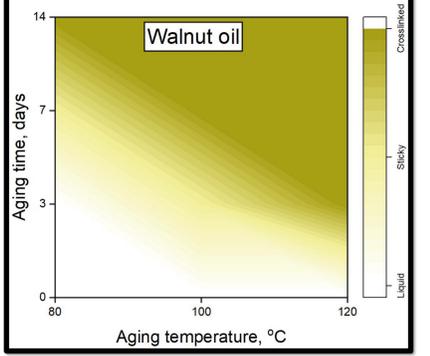
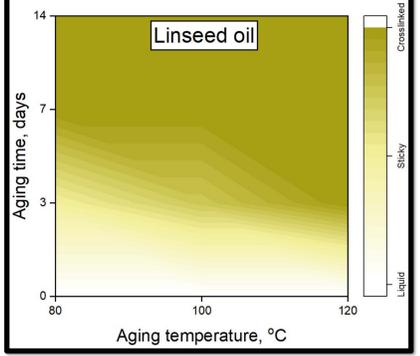
FLEXURAL PROPERTIES



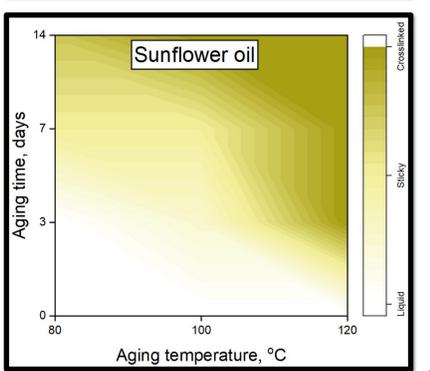
SURFACE WETTABILITY



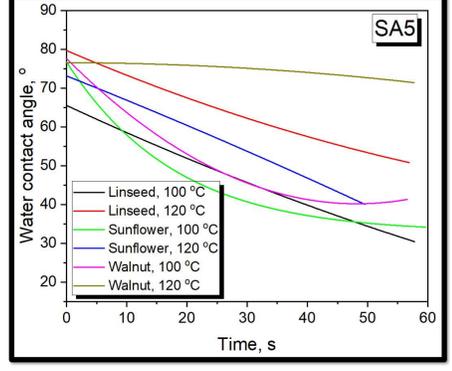
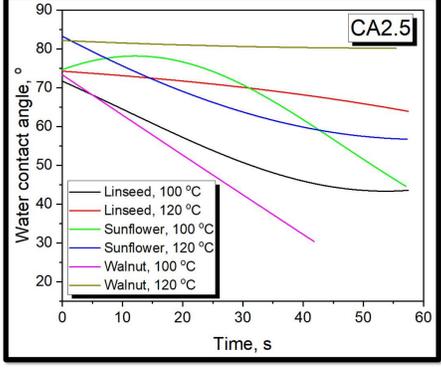
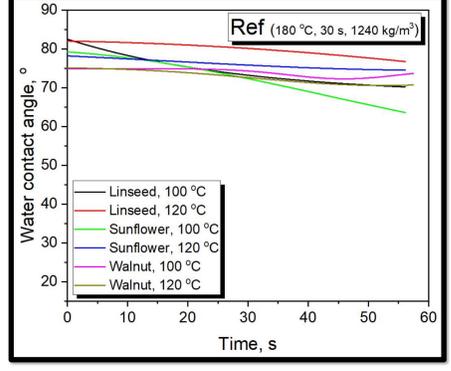
OIL COATING SELECTION



Peanut, hazelnut, and sesame oils were not suitable due to the crosslinking at 120 °C only after 14 days.



SURFACE WETTABILITY AFTER COATING



Flexural modulus
861 ± 7 MPa **734-1109 MPa**

Flexural strength
6.8 ± 0.2 MPa **4.80-5.92 MPa**



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