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Agri-food waste reusing for less impacting plastic materials

Conference topic: Green chemistry applied to renewable resources, extraction, functionalisation, biomass, valorisation

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Introduction

The recovery and valorisation of waste materials is one of the new frontiers of the circular economy and green chemistry strategies. In particular, huge amounts of waste materials are produced by agri-food and textile sectors. If the potential of these wastes is not correctly exploited, their ultimate destination will be disposal via a waste management system which require processing time, energy and additional costs. Furthermore, considering the entity of the additional economic resources that can be required it is possible that innovative processes on scaling up phases run into lacks of sustainability that may compromise the feasibility of the process itself, even for high-values products. On the contrary, by reversing the traditional perspective, bio-based wastes can become a valuable source of many valuable substances that can be used in various applications. In this context, the valorisation of *"the low value residues"* for the development of new materials from waste is one of the many ways to take into consideration. The end of a production process becomes the beginning of a new cycle, different and often with unusual outcomes. According to Plastics Europe, the global plastics production increased to 390.7 million tonnes in 2021 (352.3 million tonnes of Fossil-based, 32.5 million tonnes of post-consumer recycled and 5.9 of biobased). It was estimated that, considering the actual trend, by 2040 about 69 million metric tons will be annually disposed of in landfills and about 30 million metric tons will be mismanaged in oceans (1/3 of value estimated in 2016). In general plastic products accidentally released in seawater and beaches can cause serious environmental damages such as transport and vehiculation of foreign microbial/pollutant species, choking hazard to seabird and fishes which can exchange plastic fragments for food. The degradation phenomena which can occur on plastic products mainly due to environmental action such as solar irradiation, oxygen presence and hydrolysis can lead to the formation of microplastics, commonly classified ad fragment smaller than 5 millimetres. Against this background, possible strategies to respond to the necessity for the reduction of the plastic waste impact on different environments, take into account firstly the investigation of the potential impacts of plastics and microplastics on specific environments and at last, but not least, the evaluation of the valorisation of agro-industrial waste for the production of innovative plastic materials with tuned biodegradability.

Experimental

By designing sustainable processes, composite materials are prepared in our research group by melt blending on lab scale to optimize the processing conditions. In general, biobased-polymers such as

hydroxylated and/or poly-condensate biopolymers while both inorganic and organic fillers/additives are studied. The surface and bulk morphologies are investigated by optical microscopy and SEM and the chemical behaviours of these innovative materials are evaluated by infrared spectroscopy. As for thermal stability, crystallinity and glass transitions, TGA and DSC analysis are carried out considering various conditioning. Melt rheology and the water vapor permeability at various humidity/temperature conditions are investigated in order to further evaluate possible applicative approaches.

Results and Discussion

Our studies are mainly focused on the lab scale production and characterization of innovative composites from biobased polymer matrixes and biowastes from various production lines as tomato, wool, fishing, legumes and stone. In specific cases, the optimization of the interaction between polymers and fillers/additives can required of surface modifications and/or extractive pre-treatments in order to enhance the compatibilization between the different materials on the composite textures. The compounding of bio-based polyesters with natural materials followed by a detailed characterization allows us to evaluate possible applications and effects due to the use of the different waste materials.

Figure 1. Composites films of biobased polymers and various waste materials produced by hot press moulding

Conclusion

It is possible to give a new life to bio-based industrial waste from the different industries through the possible valorisation of waste materials for new applications. In some cases, it was also possible to scale up to a pilot and furthermore to industrial level. Important variations on composites behaviour have been achieve in various cases, as example the decreasing of melt complex viscosity, the improve of the ductility and the easier degradation in natural environment.

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Biography

Leonardo Arrighetti received his master's degree in industrial chemistry from the University of Pisa. Currently he works as research fellow at Pisa Division of the Institute for Physical and Chemical Processes of the Italian Research Council (Cnr-Ipcf). His work is mainly focused on the preparation, study and consequent optimization of polymer composite materials/blends starting from biodegradable matrixes as PLA and various types of agri-food waste in order to obtain innovative materials. Recently he has joined the WoW group (Win on Waste), working on the degradation study of virgin plastics or of plastic products for commercial use in marine ecosystems such as sea depths and beaches.