A Novel Approach towards the Circular Economy of Plastics

ISOPREP: Ionic Solvent-based Recycling of Polypropylene Products

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Strong, lightweight, versatile, low cost and moldable, plastics have become an integral part of our lives. They are used in the production of thousands of different products such as packaging materials, textiles, and household appliances that bring convenience, comfort, and safety to our everyday lives. Additionally they enable technological innovations, especially in the medical, building, automotive and aerospace sectors, leading to new solutions and improvements. Plastics production ramped up from 1.5 million tonnes in 1945 to over 360 million tonnes in 2019. However, the remarkable rise in the use of plastics has coincided with an equally dramatic rise in environmental pollution problems [1].

Approximately 8.3 billion metric tons of plastics have been produced worldwide since 1950, less than 20% of which have been recycled or incinerated, leaving about 80% to accumulate in the environment. The million tonnes of plastic litter that end up in the landfills and oceans are the most visible signs of the environmental problems caused by plastics, which have also triggered growing public concern. Given these environmental problems and the ever increasing demand for plastics, there is an urgent need for new innovative recycling methods that will not only help protect the environment by eliminating waste and reducing greenhouse gas emissions and dependence on fossil fuels but also contribute to the circular economy by upcycling and by maximizing the value of recycled materials [2,3].

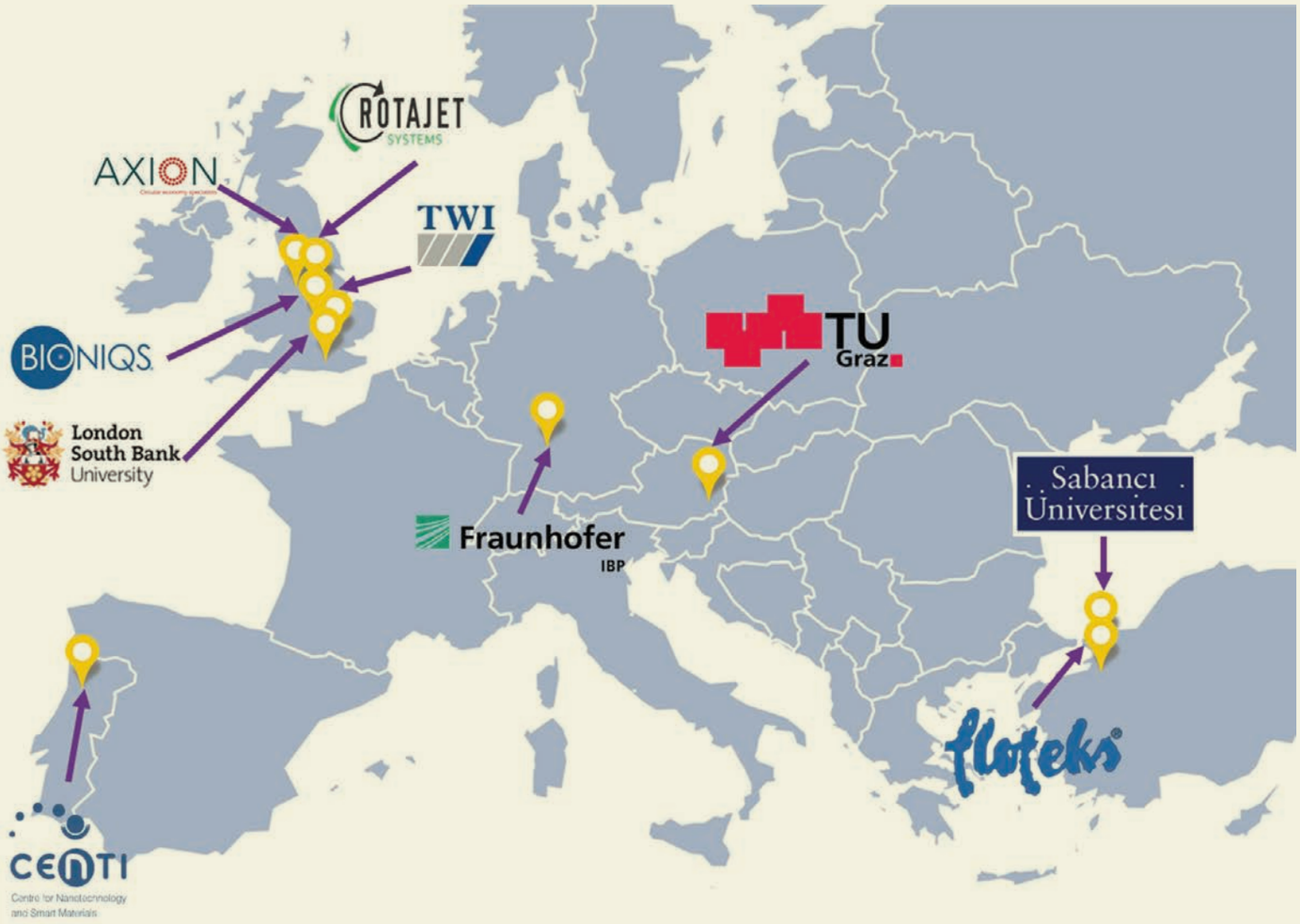
Figure 1: *The concept of the ISOPREP project.*

The ISOPREP project, the concept of which is shown in Figure 1, has officially joined the fight against plastic pollution, with a green solvent-based chemical recycling technology intended to recover virgin quality polypropylene from end-of-life polypropylene (PP) products.

PP, with a global market expected to reach $133 billion/year by 2023, is the second most used commodity polymer after polyethylene. As only 1% of PP is currently being recycled, it is one of the main factors in environmental pollution. A notable source of PP waste arises from used carpets, which make up 17.6% of the PP product market. In the UK alone, approximately 400,000 tons of waste carpet are generated each year, 66% of which ends up in land fill and takes 20-30 years to completely decompose in a natural setting. The majority of the carpet waste is incinerated to produce energy, which not only releases CO_2 into the atmosphere but also disregards the value of PP as a resource and necessitates further consumption of fossil resources to replace the lost PP within the plastics supply chain. On the other hand, existing methods for the recycling of PP mainly rely on mechanical processing, which results in an impure product that can only be used for lower value applications or at best requires re-blending with virgin material [4].

By contrast, the aim of the ISOPREP project is to develop a process that recycles end of life PP back into its original virgin quality, making it completely suitable for re-use in high value applications. The proprietary recycling technology in ISOPREP will be scaled up in a 1 ton pilot plant to produce virgin quality PP. The project will also run on the basis of a full life-cycle analysis within the framework of the circular economy.

ISOPREP is a 3-year project with a budget of € 6.3M, funded by the Horizon 2020 programme under a specific call to provide efficient recycling processes for materials containing plastics. ISOPREP is a venture undertaken by a multidisciplinary consortium (Figure 2) represented by 10 partners across 5 different European countries. The project is coordinated by TWI Ltd. (Cambridge, United Kingdom), and the consortium partners include the Advanced Resins and Coatings Technologies Innovation Centre (ARCTIC), Floteks, Fraunhofer, Sabanci University, Bioniqs Ltd., the Institute of Processing and Engineering (IPPE), RotaJet Systems Ltd., Axion Recycling Ltd., and the Centre for Nanotechnology and Smart Materials (CENTI).



As part of the ISOPREP consortium, Sabancı University's Integrated Manufacturing Technologies Research and Application Center (SU-IMC) has received €723,000 for the optimization of the proposed PP recycling steps in SU-IMC laboratories and for the verification of the whole recycling process in the laboratory-scale pilot plant. The center will also contribute to material characterization efforts throughout the project and to the exploration of different application areas in which the recycled PP polymer can be utilised. The ISOPREP project at SU-IMC is led by Asst. Prof. Serkan Ünal, and the team members include Prof. Yusuf Menceloğlu, Assoc. Prof. Bekir Dizman, Dr. Serkan Güçlü, Dr. Nuray Kızıldağ and Erdal Balcı.

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