

IonoSolv process on plasterboard waste – a new approach to upcycle construction waste

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The construction and demolition industry (C&D) contributes with up to 40% of global emissions. In C&D, apart from the main issue regarding GHG emissions from concrete production, another problem is plasterboard (PB) manufacturing, which reached 150 million tonnes produced worldwide. Plasterboard (PB), also called drywall or gypsum board, is a composite gypsum-based material, increasingly used since the 1940s in European countries for the construction of interior walls¹. PB comprises primarily of gypsum (calcium sulphate dihydrate, CaSO₄·2H₂O) and additives such as starch, vermiculite, soap foam, flame retardants, shredded paper and accelerators². PB is extensively utilised as a surface covering material in both commercial and residential structures. It is available in fire-resistant and general-purpose varieties, functions as a readily applicable and resilient cladding for walls, floors, and ceilings. It offers easy installation, low cost, and beneficial properties such as sound attenuation and thermal insulation³.

PB production in 2022 reached 28 billion square feet in the US and around 3 billion square feet in the UK, such volume raises concerns regarding its disposal and reuse. The end-of-life of PB waste follows typically one of three routes: recycling, landfilling, or incineration. Ideally, PB waste can be recycled, where it is processed to recover gypsum and fibres that can be reused in new PB or other construction materials. However, recycling rates for PB remain low due to challenges in separation, contamination, and processing costs. In many cases, especially in regions without robust recycling facilities, PB waste is sent to landfill. This poses environmental risks, as gypsum can generate hydrogen sulphide gas when it breaks down under anaerobic conditions, creating a toxic and unpleasant odour and contributing to air pollution⁴. Some facilities incinerate PB waste, but this releases sulphur dioxide and other emissions unless strict controls are in place.

Protic ionic liquids (PILs) are a different subset of ILs, a cheaper and more efficient alternative⁵. Synthesis of PILs is simpler – Brønsted acid-base neutralisation reaction – and they can be readily recycled without compromising extraction efficiency. PILs also do not require anhydrous conditions, which makes them water-friendly, easier to handle and less costly. PILs have been proven successful in pre-treating diverse feedstocks, from plant biomass, e.g. grasses, softwoods and hardwoods, to marine sources crustacean shells^{5,6}. This project focused on exploring different pathways to deconstruct PB waste to produce different added-value streams (Figure 1). The idea is to explore PILs selectivity towards different components of PB waste, e.g., the lignin from the fibres, and then amplify the range of products that can be obtained, ultimately diversifying the lignocellulosic and construction waste biorefinery.

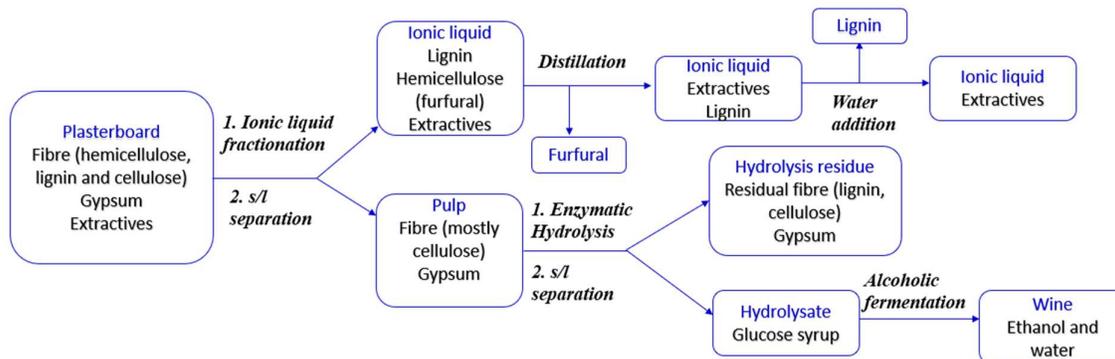


Figure 1. IonoSolv fractionation of PB waste.

References

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Dr. Pedro Nakasu received his Ph.D. in Chemical Engineering (2019) at State University of Campinas. He joined Imperial College as a research assistant in 2021. His past work entailed biomass fractionation of Brewer's spent grain with ionic liquids for applications in biorefinery with special attention to protein utilisation. He also has special interest in shellfish waste utilisation to produce chitin and focus on the whole utilization of each fraction such as protein, pigments, inorganic salts and chitin. After fractionation of shellfish waste, he is aiming for applications in wastewater treatment, packaging and hydrogel formulations. His late projects entail fractionation of construction gypsum waste with ionic liquids and production of platform chemicals from IonoSolv pretreatment pulps.