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**Abstract**

# Breaking New Ground with Polysaccharides in Sustainable Additives

Polysaccharides are a class of natural polymers that are very attractive, given their intrinsic sustainability attributes and their broad and flexible application functionality. However, current native polysaccharides, such as cellulose, hemicelluloses, and starch, often lack the purity and precise molecular design found in most incumbent synthetic polymers. Enzymatic polysaccharide polymerization technology can address some of the current limitations of naturally occurring polysaccharides. This technology enables the industrial-scale synthesis of high-purity and precisely structured polymers, such as linear alpha-1,3-glucans and branched alpha-1,6-1,3-glucans. The bottom-up assembly of insoluble polysaccharide polymers from soluble glucose monomers allows for the design of novel colloidal features, which, in turn, enable their use in many industrial applications. Thus, enzymatic polymerization combined with novel post-sequence functionalization technologies offers great potential to meet the purity and control offered by synthetic polymeric materials while improving, by design, the increasingly stringent end-of-life requirements.

International Flavors & Fragrances (IFF) has developed the proprietary enzymatic polymerization technology to produce DEB™ (Designed Enzymatic Biomaterials), which are utilized by IFF for homecare and personal care applications. In partnership with Kemira, the objective has been to adapt this innovative technology to align with Kemira's strategic focus areas in Packaging Solutions, as well as Water Solutions.

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To date, various application areas within pulp and paperboard have been targeted, including dry strength, fixation, and WQQM(Water Quality and Quantity Management). In these applications, the alpha-glucan is modified to produce cationic or anionic water-soluble polymers, complementing the primary incumbent chemistries, such as polyacrylamides and polyamines.

In both municipal and industrial wastewater treatment, cationic coagulants are employed to enhance COD and suspended solids separation. These applications present significant potential for the use of cationic alpha-glucans.

The use of conventional, fossil-based plastics to achieve barrier solutions for paperboards and molded fiber is under increasing pressure due to constantly tightening regulations aimed at reducing and entirely replacing non-circular, fossil-based materials. Alpha-glucan barrier properties have been proven in pilot projects, meeting high oil and grease resistance and oxygen barrier requirements on fiber-based substrates for food and non-food applications. We see great potential not only to replace conventional plastic with equally performing stand-alone alpha-glucan or as part of a renewable barrier structure, but also to elevate the already high sustainability profile of fiber-based packaging and products to new levels.

To enable a significant leap in the utilization and market potential of polysaccharides in industrial applications, more impactful derivatization and functionalization technologies need to be developed and scaled up. Collaborations between academia, research institutes, the chemical industry, and end-users are of vital importance.

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