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Application of exopolysaccharides to improve the performance of ceramic bodies in the unidirectional dry pressing process

Inês Caneira (1), Bernardino Machado-Moreira (1), Amélia Dionísio (1), Vasco Godinho (2), Orquídia Neves (1), Diamantino Dias (2), Cesareo Saiz-Jimenez (3), Ana Z. Miller (1,3)

(1) CEPGIST/CERENA, Instituto Superior Técnico, Universidade de Lisboa, Lisbon, Portugal, (2) Rauschert Portuguesa, SA, São Domingos de Rana, Portugal, (3) IRNAS-CSIC, Seville, Spain

Ceramic industry represents an important sector of economic activity in the European countries and involves complex and numerous manufacturing processes. The unidirectional dry pressing process includes milling and stirring of raw materials (mainly clay and talc minerals) in aqueous suspensions, followed by spray drying to remove excess water obtaining spray-dried powders further subjected to dry pressing process (conformation). However, spray-dried ceramic powders exhibit an important variability in their performance when subjected to the dry pressing process, particularly in the adhesion to the mold and mechanical strength, affecting the quality of the final conformed ceramic products. Therefore, several synthetic additives (deflocculants, antifoams, binders, lubricants and plasticizers) are introduced in the ceramic slips to achieve uniform and homogeneous pastes, conditioning their rheological properties. However, an important variability associated with the performance of the conformed products is still reported.

Exopolysaccharides or Extracellular Polymeric Substances (EPS) are polymers excreted by living organisms, such as bacteria, fungi and algae, which may confer unique and potentially interesting properties with potential industrial uses, such as viscosity control, gelation, and flocculation. Polysaccharides, such as pullulan, gellan, carrageenan and xanthan have found a wide range of applications in food, pharmaceutical, petroleum, and in other industries. The aim of this study was the assessment of exopolysaccharides as natural additives to optimize the performance of spray-dried ceramic powders during the unidirectional dry pressing process, replacing the synthetic additives used in the ceramic production process. Six exopolysaccharides, namely pullulan, gellan, xanthan gum, κappa- and iota-carrageenan, and guar gum were tested in steatite-based spray-dried ceramic powders at different concentrations. Subsequently, these ceramic powders were submitted to unidirectional dry pressing process (conformation) and the green conformed bodies were tested on the following properties: mechanical flexural strength and adhesion/disaggregation of the conformed material. The binding state of polysaccharides and mineral grains was evaluated by field emission scanning electron microscopy (FESEM).

Our data showed that xanthan gum and pullulan were the most effective polysaccharides in improving the performance of spray-dried ceramic powders during unidirectional dry pressing process, in comparison to the control steatite-based ceramic bodies containing synthetic additives. In addition, these polysaccharides yielded the best cost-benefit relationship, representing an eco-friendly and cost-effective alternative to synthetic additives used in technical ceramics industry. Hence, this study has contributed to define a new and sustainable strategy to improve the performance of ceramic materials during unidirectional dry pressing process, reduce production costs and minimize environmental impact.

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