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Viscous Control of the Foam Glass Process

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The production of foam glass as heat insulating material is an important industrial process because it enables low-cost recycling of glass waste from a variety of chemical compositions. Optimization of the foaming process of new glass waste compositions is time consuming, since many factors affect the foaming process such as temperature, particle size, type and concentration of foaming agent. The foaming temperature is one of the key factors, because even small temperature changes can affect the melt viscosity by several orders of magnitude. Therefore, it is important to establish the viscosity range in which the foaming process should take place, particularly when the type of recycled cullet is changed or several types of cullet are mixed in one batch. According to recent glass literature, the foaming process should occur at viscosity 10^3 to 10^5 Pa s. However, no systematic studies have hitherto been conducted concerning how the melt rheology influences the foam glass process and if any universal optimum viscosity exist for foaming different types of glass cullet. In this work, we show the details of viscous control of glass foaming processes. We have measured the viscosity-temperature relationships for several types of glasses, and carried out the foam processes at different viscosities by using $CaCO_3$ as foaming agent to find a common optimum viscosity for all the tested glasses. We also measured the particle size distribution of the recycled cullet, and quantified the degree of foam expansion through density measurements. The produced foam glasses have also been characterized in terms of the fraction of open vs. closed pores and crystallization and glass transition behaviour. Finally, we have found a minimum in the glass foam density when the foaming has been performed at viscosities of around 10^4 to 10^5 Pa s.