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Effect of Additives on Manufacturing of Ceramic Foams

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Abstract – In this work, Al_2O_3 and Y_2O_3-stabilized Zirconia (YSZ) foams were produced by the replication method using slurries with different concentrations and type of additives (binder, dispersant, antifoam, and solvent). The Taguchi's method was applied to quantify the effect of each additive on the mass gain of the ceramic foams during processing. The results revealed that the critical factors in mass gain are the solids content and binder amount. However the homogeneity of the coating is related to the type and concentration of the binder, and the dispersant type.

The ceramic foams are commonly produced by the replication method, which consists in the impregnation of a polymeric flexible template (i.e. polyurethane foam) with a ceramic suspension (slurry) containing the appropriate additives, followed by heat treatments to burning out organic compounds, additives and promote sintering of the ceramic structure. In this manufacturing process reproducibility is a difficult task due to the variability of the slurry characteristics caused by selected additives. For this reason, therheological behavior of the slurry is a key factor in the ceramic foam manufacture, which directly affects the ceramic coating on the polymer matrix during impregnation.

The ceramic foams were produced by impregnation of polyurethane foams of 20 pores per inch (FoamPartner GmbH, Switzerland). Coated polyurethane foams were compressed (50%) to remove slurry excess that could lead to the formation of closed cells, and dried for 24 h at room temperature. The foams were then submitted to thermal cycles. Slurries involved in the impregnation step were manufactured using 3 different concentrations and type of binder, dispersant, solvent (with and without defoamer), and two ceramic powders (YSZ, Al_2O_3). The Taguchi's method with an orthogonal array $L_{18}(2^1X3^7)$ was used for the factor analysis [1].

The results showed that the critical factors in the impregnation step (retained mass in the polyurethane foam) are the solids content and binder amount with a confidence level of 99%; (Figure 1). On the other hand, an uniform, homogeneous coating is more likely related to the dispersant quantity, dispersant type and binder type. The factors that affect the mass gain, also affect the pseudoplasticity of the suspension, which drives the impregnation behavior, this observation are in agreement with previous work [2].

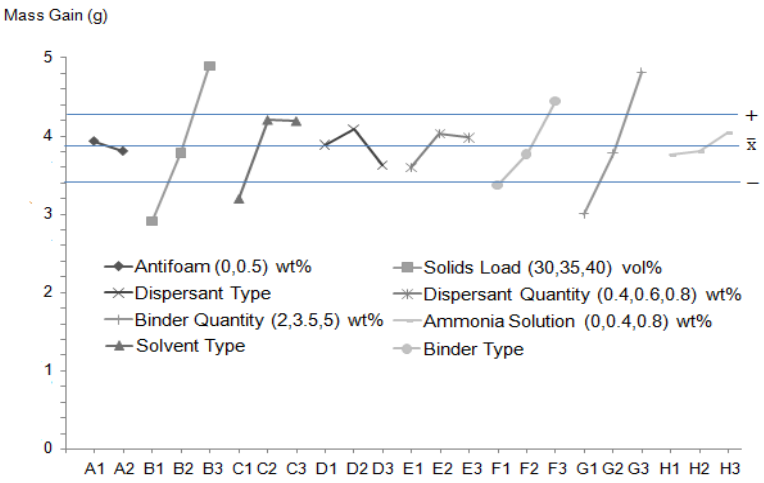

Figure 1: Mass gain in the impregnation (interval confidence level of 99%)

[1] G. Taguchi, S. Chowdhury and Y. Wu. TAGUCHI's Quality Engineering Handbook, New Jersey, 2005, WILEY.
[2] S.Y. Gómez, J.A. Escobar, O.A. Alvarez, C.R. Rambo, A.P. Novaes de Oliveira, D. Hotza, J Mater Sci, (2009), DOI:10.1007/s10853-009-3462-3.