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Cold roll pressing of thin ceramic substrates

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Abstract – Once dense substrates with thin thickness are of a great technological interest, such as application in biosensors and oxide solid fuel cell components, it was evaluated the viability to form substrates with thin thickness by cold roll pressing from a zirconia plastic mass. In this way, it was analyzed the final properties of the substrates obtained by cold roll pressing such as percentage of theoretical density, apparent porosity, shrinkage, microstructure, and compared to the alumina substrates previously obtained by the same method.

Dense substrates with thin thickness of pure oxides have been used for electro-electronic devices, such as biosensors and oxide solid of fuel cell components; however it has been searched thinner thickness ever more [1]. Traditional methods of ceramic forming, pressing and extrusion, limit the minimum thickness of the final product, and more complex methods as the tape casting, requires toxic additives and high costs. So it was studied the viability to conform zirconia substrates as well the alumina plastic mass was processed, by cold roll pressing, an alternative route that applies a low amount of additives, in a simple way and economically viable [2].

The zirconia plastic mass was obtained by the mixture of the zirconia powder, 12%w of additives, plasticizer and lubricant, and 15%w of water as solvent. This mass was crossed through the rollers and the rotation of the rollers ranging between 12, 15 and 25rpm; the average thickness was about 400 μm. After forming the samples were sintered at 1520ºC/1h. Alumina substrates were sintered at 1600ºC/1h.

The substrates resulted in a percentage of theoretical density (TD%) about 90%, this value is higher than those of alumina, ~85% (Figure 1). As expected, the apparent porosity was lower and the shrinkage was higher, due to the better densification of these substrates. The SEM micrographs of thermally etched surfaces showed that both microstructures of alumina (Figure 2a) and zirconia (Figure 2b) have a cohesive structure, without large pores between the grains; the zirconia has a bimodal distribution of particle size [3]. It is worthy to mention that the firing conditions were not established and optimized to achieve the best densification.

The results of the final properties of the zirconia substrates prepared by cold roll pressing was satisfactory, once they were similar to the alumina substrates, which point out the viability of the process to form thin substrates with different raw materials.

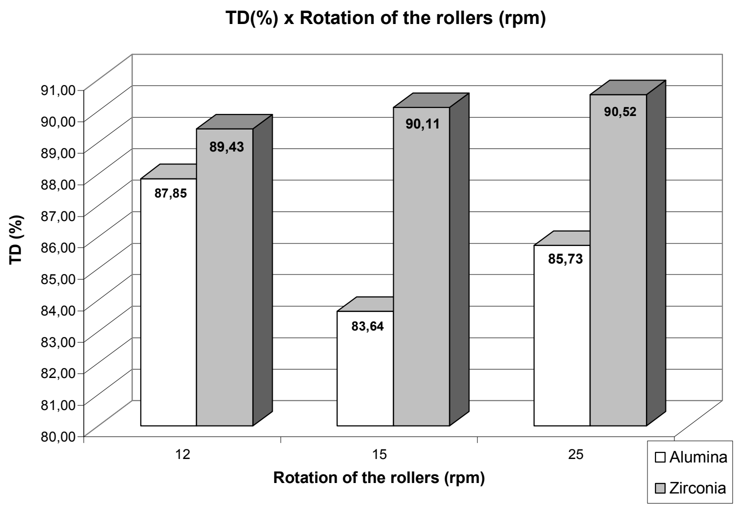

Figure 1: Percentage of theoretical density (%) x Rotation of the rollers (rpm)

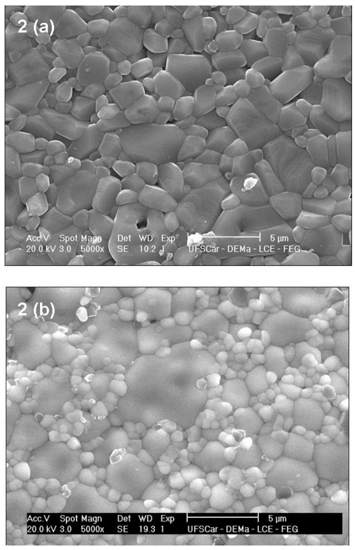

Figure 2: SEM micrographs of **(a)** alumina substrate and **(b)** zirconia substrate

[1] Lukin,E. S., et al. Dense and durable ceramics based on alumina and zirconia. **Refractories and Industrial Ceramics**. V. 45, No. 6, p 421-423, 2004
[2] VISCOUSPLASTIC PROCESSING. **Processamento viscoplástico** <http://ceram.co.uk/vpp>.
[3] KOSHIMIZU, L. **Conformação viscoplástica por rolos a frio e caracterização de substratos de alumina**. 2008. 122p. Dissertação (Mestrado em Engenharia de Materiais) – Departamento de Engenharia de Materiais, Universidade Federal de São Carlos, São Carlos.