

# Numerical Investigation of the Load Free Permanent Strain in Carbon Anode During Baking Process

Pierre-Luc Girard<sup>1</sup>, Walid Kallel<sup>2</sup>, Daniel Marceau<sup>3</sup>, Duygu Kocaefe<sup>4</sup>, Mohamed Bouazara<sup>5</sup> and Patrice Coulombe<sup>6</sup>

1. PhD Student
2. MSc Student
3. Professor
4. Professor
5. Professor

Aluminium Research Centre – REGAL, University Research Centre on Aluminium – CURAL,  
Chicoutimi, Québec, Canada

6. Director of Technological Development and Laboratory  
Aluminerie Alouette Inc., Sept-Îles, Québec, Canada  
Corresponding author: Pierre-Luc.Girard@uqac.ca

## Abstract

Baking is the final step of the anode production, which plays a major role in attaining the anode properties required by industry. However, the anode baking is a costly process during which various complex phenomena take place. It is therefore important to ensure good understanding of the impact of these phenomena on the baked anode quality. Regarding the mechanical aspect, various strain mechanisms occur in the anodes during the baking and evolve with respect to the spatial distribution of temperature and its rate of change in the baking furnace. Each of these mechanisms contributes to the stress equilibrium in the carbon anode and can lead, depending on the baking conditions, to poor mechanical properties including cracks when the failure limit is exceeded. In this paper, a new approach for the modelisation of one of these mechanism, the load free permanent strain, is presented. Experimental data obtained from free dilatometric tests were mathematically described using successive temperature activated evolutions for the phase transition, devolatilization and graphitization process. While existing parameters were used for the devolatilization evolution process, an optimization procedure was used to identify the remaining parameters of the equations. Model results showed good agreements with the experimental data.

**Keywords:** Carbon anodes; anode baking; mechanical properties; chemical swelling; baking Index.