



**HAL**  
open science

# Inverse Identification of Asymmetric Creep Parameters Using the I-DIC Technique

Lucas Breder Teixeira, Jean Gillibert, Eric Blond, Thomas Sayet

► **To cite this version:**

Lucas Breder Teixeira, Jean Gillibert, Eric Blond, Thomas Sayet. Inverse Identification of Asymmetric Creep Parameters Using the I-DIC Technique. XVI European Ceramic Society Conference, Jun 2019, Torino, Italy. hal-02611997

**HAL Id: hal-02611997**

**<https://hal.science/hal-02611997>**

Submitted on 18 May 2020

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Inverse Identification of Asymmetric Creep Parameters Using the I-DIC Technique

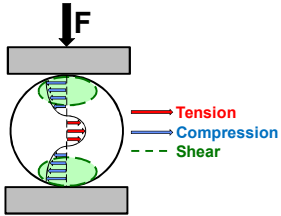
Lucas BREDER TEIXEIRA, Jean GILLIBERT, Eric BLOND, Thomas SAYET  
Univ Orléans, Univ Tours, INSA CVL, LaMé EA 7494, 45000 Orléans, France

Advanced Thermomechanical multiscale mODelling of Refractory Linings

## 1 – Introduction:

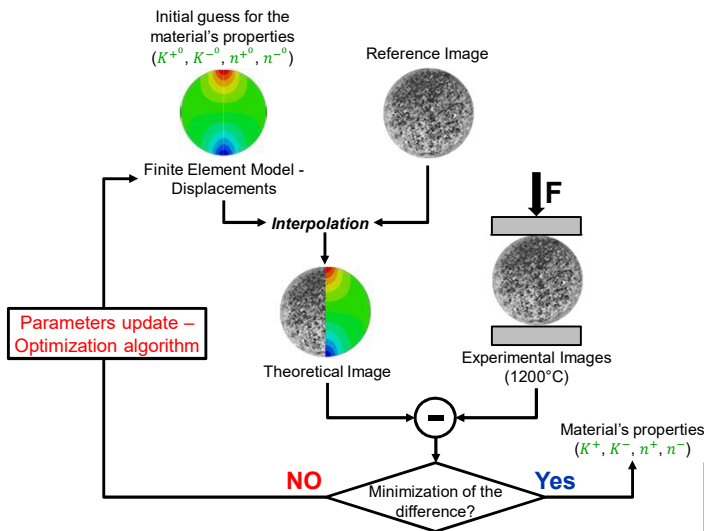
- The **creep characterization of refractory materials** at high temperatures requires **complex tests**
- This work intends to apply the **Integrated Digital Image Correlation** technique to the determination of the **secondary creep properties of refractories at high temperatures**
- It's expected to fully characterize the materials (tension, compression and shear) using a **reduced number of tests**, making use of the Brazilian test
- Images taken at **1200°C** were **virtually deformed** using an **asymmetric creep law** (different behavior under tension and compression) with known materials' parameters. Later, starting from an initial guess for the parameters, an inverse identification was run to check the I-DIC software robustness

## 2 – Brazilian test:



The **Brazilian test** presents a complex stress distribution, with **tension, compression and shear** observed in the sample at the same time. This allows the identification of the asymmetric behavior using a **reduce number of tests**

## 3 – I-DIC algorithm:



## 4 – Mathematical model:

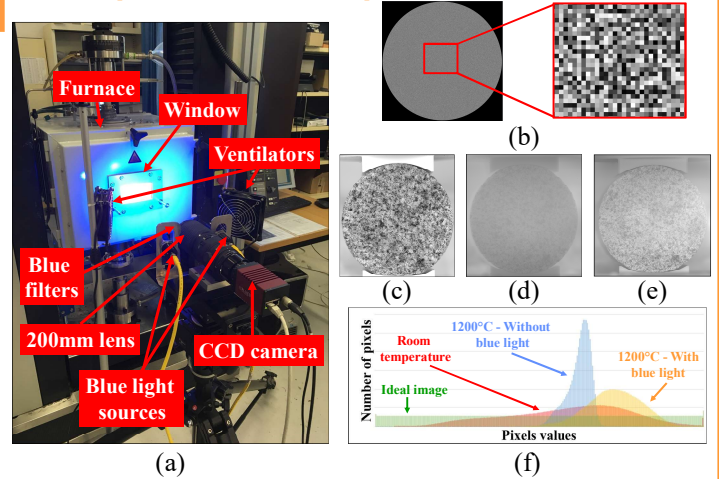
Asymmetric viscoplastic strain rate<sup>1</sup>

$$\dot{\epsilon}^p = \frac{3}{2} \frac{s^+}{\sigma_{eq}^+} \left( \frac{\langle \sigma_{eq}^+ - \sigma_y^+ \rangle}{K^+} \right)^{n^+} - \frac{3}{2} \frac{s^-}{\sigma_{eq}^-} \left( \frac{\langle \sigma_{eq}^- - \sigma_y^- \rangle}{K^-} \right)^{n^-}$$

where  $\sigma_y$  is the yield stress,  $s$  is the deviatoric stress and  $\sigma_{eq}$  is the von Mises stress.

<sup>1</sup>E. Blond, N. Schmitt, F. Hild, P. Blumenfeld, J. Poirier, Journal of the European Ceramic Society, 25(11) 1819-1827 (2005).

## 5 – Experimental setup:



(a) High temperature test setup and Brazilian test samples used with I-DIC. (b) Virtual image. (c) Room temperature. (d) 1200°C without using the blue lights. (e) 1200°C using the blue lights. (f) Images' histograms.

## 6 – Results:

A Genetic Algorithm was used to perform the inverse identification of the parameters. Tables 1 and 2 show the reference values used to create the deformed images, the range of variation used in the optimization and the identification results.

Table 1 – Reference values for the creep properties

|             | Reference values        |             | Range of variation            |                   |
|-------------|-------------------------|-------------|-------------------------------|-------------------|
|             | $K^+$                   | $n^+$       | $K_{min}^+$                   | $n_{min}^+$       |
| Tension     | $K^+ = 5773.5$          | $n^+ = 2$   | $K_{max}^+ = 6000$            | $n_{max}^+ = 2.2$ |
|             |                         |             |                               | $n_{min}^+ = 1.8$ |
| Compression | $K^- = 1.0 \times 10^6$ | $n^- = 1.5$ | $K_{min}^- = 5.0 \times 10^5$ | $n_{max}^- = 1.8$ |
|             |                         |             |                               | $n_{min}^- = 1.2$ |

Table 2 – Three best solutions given by the Genetic Algorithm

|       | Solution 1 |         | Solution 2 |        | Solution 3 |        |
|-------|------------|---------|------------|--------|------------|--------|
|       | Value      | Error   | Value      | Error  | Value      | Error  |
| $K^+$ | 5127.6     | -11.19% | 5543.3     | -3.99% | 5264.70    | -8.81% |
| $n^+$ | 2.01       | 0.27%   | 1.99       | -0.46% | 1.99       | -0.58% |
| $K^-$ | 9.71E+05   | -2.91%  | 1.25E+06   | 24.97% | 1.08E+06   | 8.14%  |
| $n^-$ | 1.51       | 0.71%   | 1.48       | -1.10% | 1.51       | 0.35%  |

## 7 – Conclusions:

- The **I-DIC technique** is a convenient option to perform **inverse identification of mechanical parameters at high temperatures**
- For future works, the creep parameters of refractory materials will be identified using **experimental images**

## ESR Position 09

## Supervisors & University

## Acknowledgments



**Lucas BREDER TEIXEIRA**

Early Stage Researcher

mail: lucas.breder-teixeira@univ-orleans.fr

Eric BLOND, Thomas SAYET, Jean GILLIBERT



This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement no.764987

## Consortium of 15 European Partners