# IN SITU MEASUREMENTS OF PARTIAL DISCHARGE PATTERNS ON POROUS YSZ PELLETS PRESSED BETWEEN PLANAR PLATINUM ELECTRODES USED FOR FLASH SINTERING

Jean-Francois Fagnard, Department of Electrical Engineering and Computer Science Montefiore Institute, University of Liege, B4000 Liège, Belgium
fagnard@montefiore.ulg.ac.be
Caroline Gajdowski, Belgian Ceramic Research Centre, avenue gouverneur Cornez, 4, B7000 Mons, Belgium
Laurent Boilet, Belgian Ceramic Research Centre, avenue gouverneur Cornez, 4, B7000 Mons, Belgium
Jean-Pierre Erauw, Belgian Ceramic Research Centre, avenue gouverneur Cornez, 4, B7000 Mons , Belgium
François Henrotte, Department of Electrical Engineering and Computer Science Montefiore Institute, University of Liege, B4000 Liège, Belgium
Christophe Geuzaine, Department of Electrical Engineering and Computer Science Montefiore Institute, University of Liege, B4000 Liège, Belgium
Philippe Vanderbemden, Department of Electrical Engineering and Computer Science Montefiore Institute, University of Liege, B4000 Liège, Belgium

Key Words: partial discharges, YSZ, electrodes, contact resistance, flash sintering.

Flash sintering of prismatic or cylindrical samples placed between planar electrodes allows processing larger volumes of material, compared to dogbone-shaped samples. The contact surface with platinum electrodes are usually coated with Pt paste in this setup, in order to improve the galvanic contact with the sample, and obtain a better current homogeneity. This coating is however too expensive for industrial applications whenever large surfaces are involved. Nevertheless, a homogeneous contact resistance remains in all cases essential to control the uniformity of the electrical current through the sample, hence the importance of an accurate characterization of the quality of the contact between electrodes and sample in the non-coated case.

We propose to analyse the Partial Discharges (PDs) patterns obtained by Phase Resolved Partial Discharge (PRPD) method as an in situ measurement technique to study this problem. The setup consists in placing a ceramic sample in a furnace in the same configuration as flash sintering experiments but at a temperature lower than the onset temperature of the material. In this work, porous cylindrical samples of stabilised zirconia (average dimensions of 9 mm in diameter and 5 mm in height) are studied between 200°C and 400°C.
A 50 Hz AC voltage is therefore applied to the sample and increased gradually up to 1.7 kV. The sample is connected in parallel with a 1 nF coupling capacitor in series with a quadrupole used to separate the high frequency current of the partial discharge signals from the AC current at 50 Hz.

At a given amplitude of the applied voltage, we record for 60 s the patterns of partial discharges, their number and their phase with respect to the applied voltage. We compare the partial discharge signals to the net AC current at the power frequency measured simultaneously with a current probe at the primary winding of the low noise transformer.

At a given temperature, we notice that well-defined patterns of low amplitude partial discharges appear when the applied voltage is increased above 300 V. At much higher voltages, partial discharges of larger amplitudes initiate and grow rapidly as well as the net 50 Hz current which increases non-linearly resulting from the temperature rise of the sample and its associated resistivity drop (similarly to what happens in (pre-)flash sintering conditions). Cross examination of the sample surface by optical microscopy shows physical traces related to the occurrence of partial discharges. For comparison, a YSZ sample coated with Pt paste is also analysed in the same conditions. In that case, at the same temperature and for applied voltages up to 1 kV, partial discharge patterns are almost inexistent.

These results show that the partial discharge measurement is an efficient technique that can be used in situ prior to flash sintering experiments in order to assess the quality of the contact between the electrodes and the sample when no Pt paste is used.

This study is supported by ERDF and the Walloon Region, in the frame of IMAWA-FLASHSINT research project (program 2014-2020).