

Development of a NOx and NH3 sensor for automotive exhaust applications and control of industrial process

Gita Nematbakhsh Abkenar, Mathilde Rieu, Philippe Breuil, Jean-Paul

Viricelle

► To cite this version:

Gita Nematbakhsh Abkenar, Mathilde Rieu, Philippe Breuil, Jean-Paul Viricelle. Development of a NOx and NH3 sensor for automotive exhaust applications and control of industrial process. Journée Scientifique 2018 du Codegepra, Nov 2018, Saint-Etienne, France. , Journée scientifique du CODEGEPRA - Le Génie des Procédés en Rhône-Alpes Auvergne, pp.P4. hal-01973343

HAL Id: hal-01973343 https://hal.science/hal-01973343

Submitted on 8 Jan 2019

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.

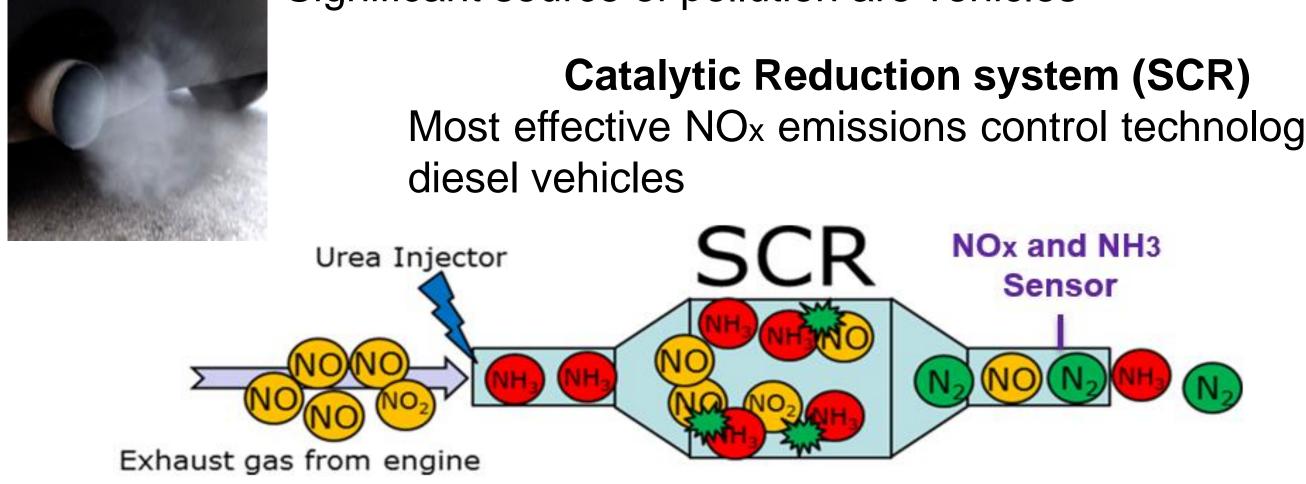
Saint-Étienne

Development of a NOx and NH3 sensor for automotive exhaust applications and control of industrial process emissions

Gita NEMATBAKHSH ABKENAR, Mathilde RIEU, Philippe BREUIL and Jean-Paul VIRICELLE **Mines* Saint-Etienne, Univ Lyon, CNRS, UMR 5307 LGF, Centre SPIN, F - 42023 Saint-Etienne, France *Correspondence: gita.nematbakhsh@emse.fr

Introduction

Air pollution : Biggest concern of public and politicians Significant source of pollution are vehicles



Most effective NO_x emissions control technologies in



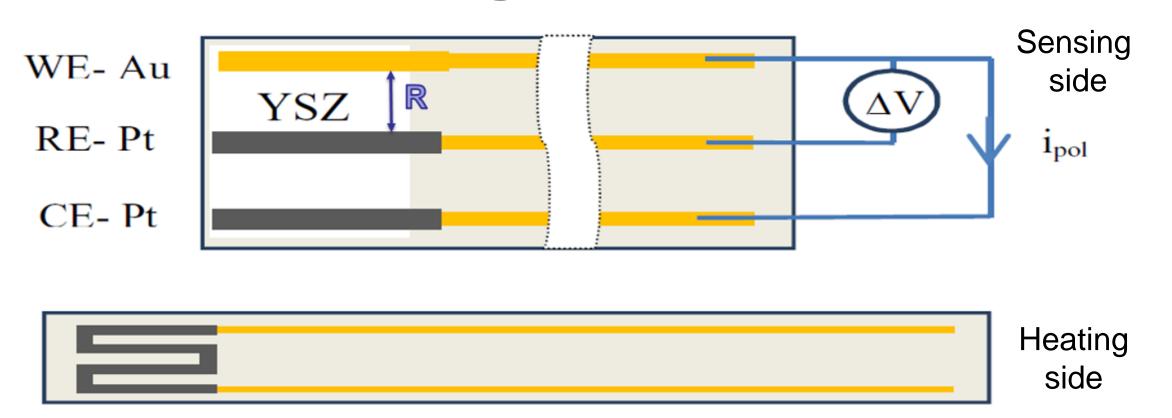
Response of sensors are for pulses of 100 ppm CO, 20 ppm NH₃, 100 ppm NO₂ and 100 ppm NO in the base gas.

Base gas: 12% O₂ and 1.5 % H₂O balanced with N₂.

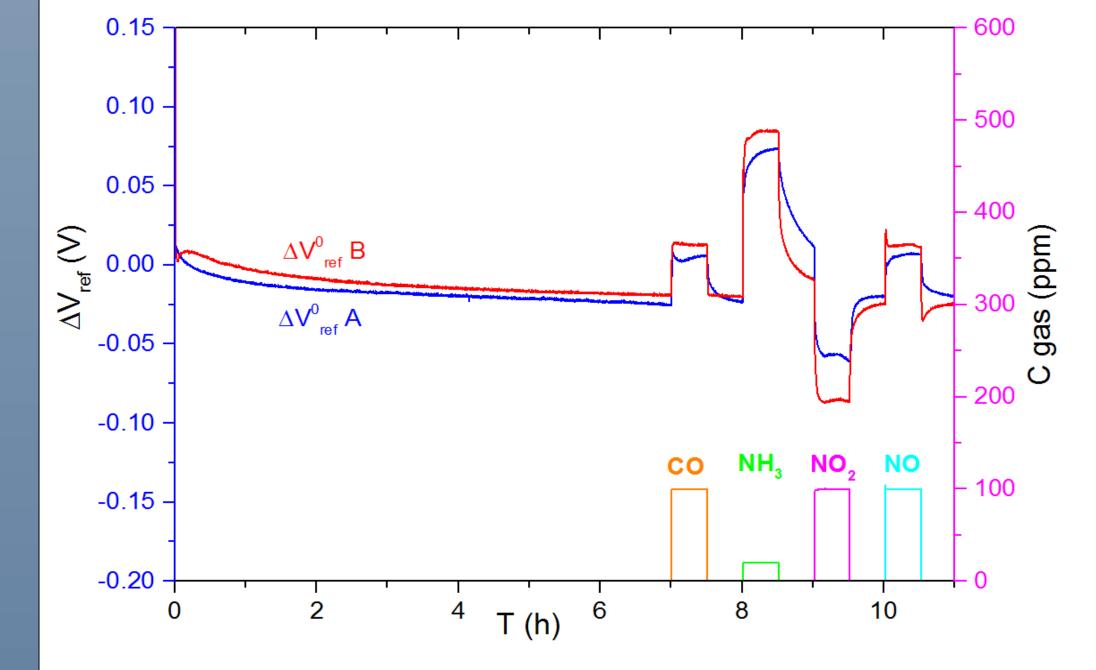
Objectives

- Chemical NOx sensor integrated with measurement of O2 and NH3
- Sensor capable of working in harsh environments

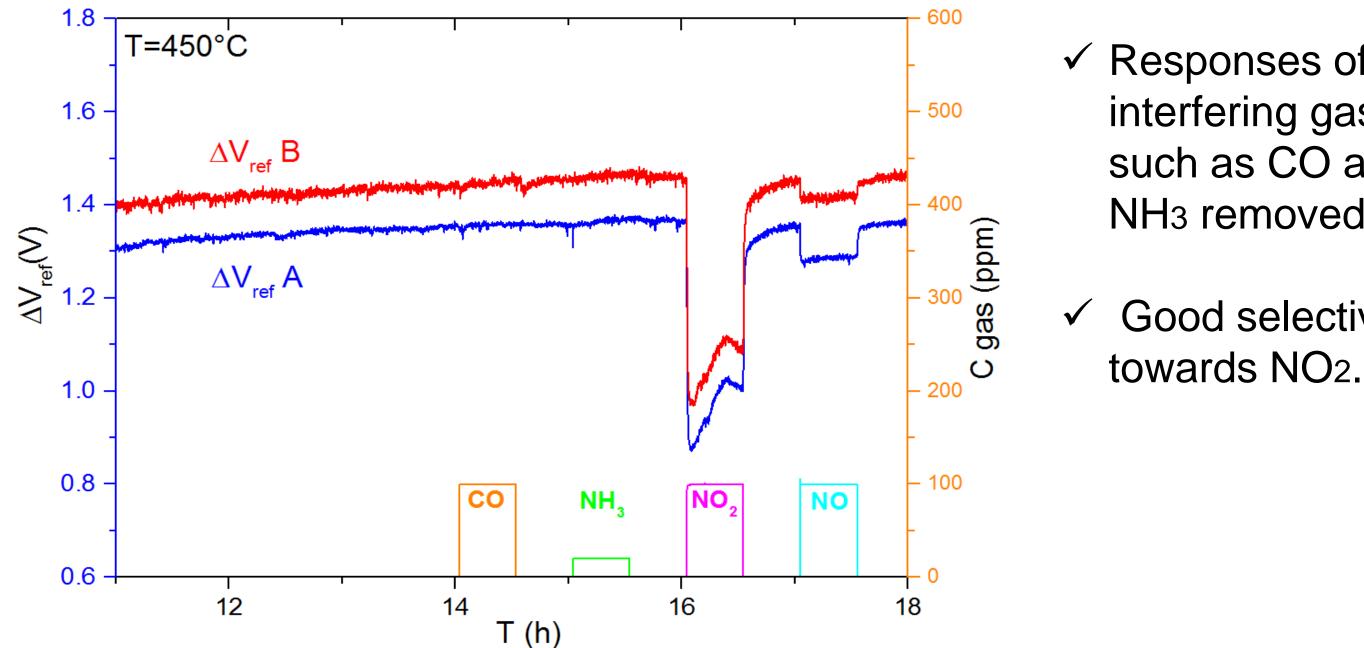
Working principle



Responses of Au(WE) sensors at 450°C No current of polarization



Polarization current of 25 nA



- ✓ Positive response for reducing gas (CO, NH₃, NO)
- Negative response for oxidizing gas NO₂.
- ✓ Responses of interfering gases such as CO and NH₃ removed.
 - Good selectivity

 $\Delta V_{ref} = E_0 + R(YSZ + Au + Pt)i_{pol} + \eta_{WE} + \eta_{RE}$

Sensor response

- R = Resistance (Ohmic drop)
- $E_0 = \text{Potential when } \mathbf{i}_{pol} = \mathbf{0}$
- $\eta_{WE}, \eta_{RE} = \text{Over potential of working}$ And reference electrode $\eta_{RE} = 0$

 $\Delta V_{ref} = V_{RE}(Pt) - V_{WE}(Au)$

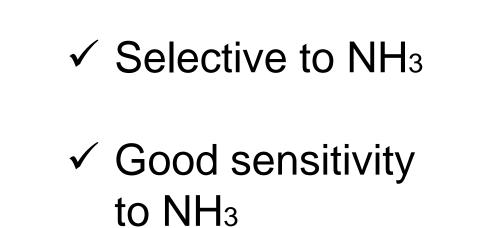
Romanytsia, I.; Viricelle, J.P.; Vernoux Ph. and Pijolat C. Application of advanced morphology AuX (X=YSZ, ZrO2) composites as sensing electrode for solid state mixed-potential exhaust NOx sensor. Sensors and Actuators B: Chemical 2015, 207, 391-397]

Viricelle J-P.; Vernoux Ph.; Gao J.; Romanytsia, I.; Breuil P.; Pijolat C. NO₂-selective electrochemical sensors for diesel exhausts. Procedia Engineering 2016, 168, 7-10]

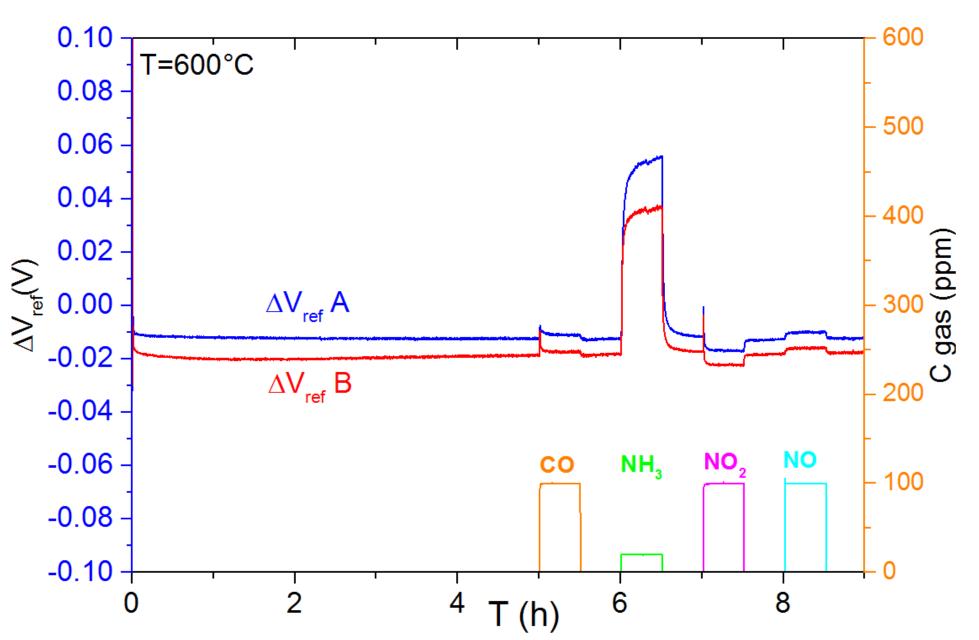
Experimental part

Fabrication of sensors by screen-printing: Two types of sensors with working electrode of Au or Au-V2O5 using commercial and home-made inks.

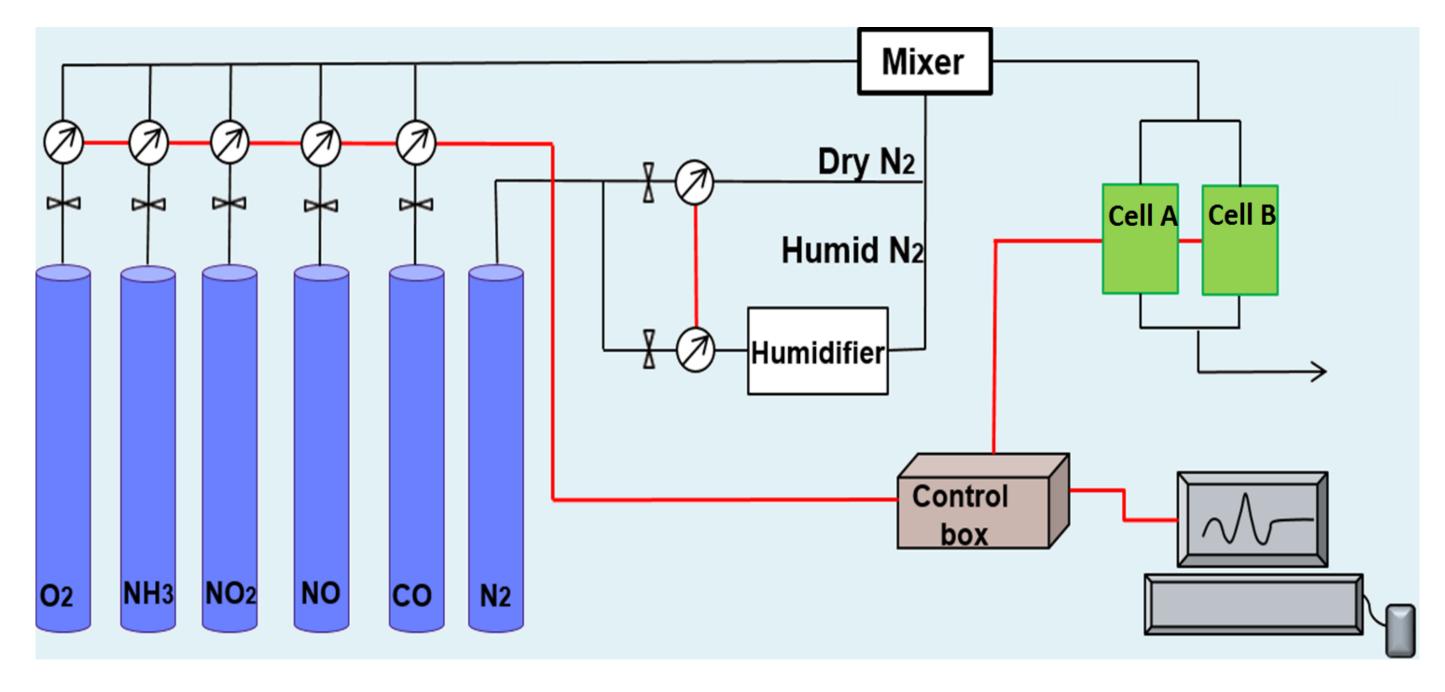
Response of Au-V₂O₅ (WE) sensors at 600°C No current of polarization



✓ Fast response and recovery times



Test bench



Conclusion

>For Au sensors, by applying a polarization current of 25 nA at 450 °C a relatively selective response to NO₂ gas is achieved.

>Au-V₂O₅ working electrodes displayed a high sensitivity to NH₃ as well as fast response and recovery times at 600 °C.

>Further investigations are needed in order to reach an integrated NOx and NH₃ sensor, which works simultaneously at the same temperature.