WP 2: Zero-drift contact temperature sensors to 1350 ºC

Partners

NPL:	Claire Elliott, Declan Tucker, (Adam Greenen), Jonathan Pearce
AFRC:	Aurik Andreu, Sarah-Louise Keegan
BRML:	Marius Neagu (Andreea-Diana Morosanu)
CCPI Europe:	Peter Cowley, Trevor Ford
PTB:	Frank Edler, Sebastian Haupt
UCAM:	Michele Scervini

March 2017

claire.elliott@npl.co.uk

Overview

Aim 1: develop integrated thermocouples

claire.elliott@npl.co.uk

Overview

Aim 1: develop integrated thermocouples

Aim 2: test for up to 6 months at AFRC and ICPE-CA

claire.elliott@npl.co.uk

Overview

Aim 1: develop integrated thermocouples

Aim 2: test for up to 6 months at AFRC and ICPE-CA

Aim 3: evaluate ultra-stable MIMS thermocouples

claire.elliott@npl.co.uk

Overview

EMPRESS
TEMPERATURE METROLOGY FOR PROCESS EFFICIENCY

Aim 1: develop integrated thermocouples

Aim 2: test for up to 6 months at AFRC and ICPE-CA

Aim 3: evaluate ultra-stable MIMS thermocouples

Aim 4: test for up to 6 months at Bodycote (UK & Romania)

Bodycote

NPL National Physical Laboratory | UNIVERSITY OF CAMBRIDGE | CCPI Europe Limited | BRML | PTB Physikalisch-Technische Bundesanstalt Braunschweig und Berlin | AFRC ADVANCED FORMING RESEARCH CENTRE UNIVERSITY OF STRATHCLYDE

claire.elliott@npl.co.uk

Overview

EMPRESS
TEMPERATURE METROLOGY FOR PROCESS EFFICIENCY

Aim 1: develop integrated thermocouples

Aim 2: test for up to 6 months at AFRC and ICPE-CA

Aim 3: evaluate ultra-stable MIMS thermocouples

Aim 4: test for up to 6 months at Bodycote (UK & Romania)

Bodycote

NPL National Physical Laboratory | UNIVERSITY OF CAMBRIDGE | CCPI Europe Limited | BRML | PTB Physikalisch-Technische Bundesanstalt Braunschweig und Berlin | AFRC ADVANCED FORMING RESEARCH CENTRE UNIVERSITY OF STRATHCLYDE

claire.elliott@npl.co.uk

Ultra-stable MIMS thermocouples

EMPRESS
TEMPERATURE METROLOGY FOR PROCESS EFFICIENCY

2-layer sheath design

Double wall

Mineral insulation & thermocouple wires

Double wall

NPL National Physical Laboratory | UNIVERSITY OF CAMBRIDGE | CCPI Europe Limited | BRML | PTB Physikalisch-Technische Bundesanstalt Braunschweig und Berlin | AFRC ADVANCED FORMING RESEARCH CENTRE UNIVERSITY OF STRATHCLYDE

claire.elliott@npl.co.uk

Ultra-stable MIMS thermocouples

EMPRESS
TEMPERATURE METROLOGY FOR PROCESS EFFICIENCY

2-layer sheath design

Cyclic testing and lab test comparison

NPL National Physical Laboratory · UNIVERSITY OF CAMBRIDGE · CCPI Europe Limited · BRML · PTB Physikalisch-Technische Bundesanstalt Braunschweig und Berlin · AFRC ADVANCED FORMING RESEARCH CENTRE UNIVERSITY OF STRATHCLYDE

claire.elliott@npl.co.uk

Ultra-stable MIMS thermocouples

EMPRESS
TEMPERATURE METROLOGY FOR PROCESS EFFICIENCY

2-layer sheath design

Cyclic testing and lab test comparison

Test for up to 6 months at

Bodycote (UK & Romania)

& 5 cycles at AFRC

NPL National Physical Laboratory · UNIVERSITY OF CAMBRIDGE · CCPI Europe Limited · BRML · PTB · AFRC ADVANCED FORMING RESEARCH CENTRE UNIVERSITY OF STRATHCLYDE

claire.elliott@npl.co.uk

Ultra-stable MIMS thermocouples

EMPRESS
TEMPERATURE METROLOGY FOR PROCESS EFFICIENCY

2-layer sheath design

Cyclic testing and lab test comparison

Test for up to 6 months at

Bodycote (UK & Romania)

& 5 cycles at AFRC

- Further details at 11.30

NPL National Physical Laboratory · UNIVERSITY OF CAMBRIDGE · CCPI Europe Limited · BRML · PTB Physikalisch-Technische Bundesanstalt Braunschweig und Berlin · AFRC ADVANCED FORMING RESEARCH CENTRE UNIVERSITY OF STRATHCLYDE

claire.elliott@npl.co.uk

Integrated thermocouples

Aim 1: Build and test an alumina thermocouple design, with an integrated reference ingot

claire.elliott@npl.co.uk

Integrated thermocouples

Aim 1: Build and test an alumina thermocouple design, with an integrated reference ingot

claire.elliott@npl.co.uk

Integrated thermocouples

Aim 1: Build and test an alumina thermocouple design, with an integrated reference ingot – without changing the external size

claire.elliott@npl.co.uk

Integrated thermocouples

Aim 1: Build and test an alumina thermocouple design, with an integrated reference ingot – without changing the external size

claire.elliott@npl.co.uk

Integrated thermocouples

EMPRESS
TEMPERATURE METROLOGY FOR PROCESS EFFICIENCY

Aim 1: Build and test an alumina thermocouple design, with an integrated reference ingot – without changing the external size

NPL National Physical Laboratory
UNIVERSITY OF CAMBRIDGE
CCPI Europe Limited
BRML
PTB Physikalisch-Technische Bundesanstalt Braunschweig und Berlin
AFRC ADVANCED FORMING RESEARCH CENTRE UNIVERSITY OF STRATHCLYDE

claire.elliott@npl.co.uk

Integrated thermocouples

Aim 1: Build and test an alumina thermocouple design, with an integrated reference ingot – without changing the external size

Lab testing

with Cu (1084 ºC) and,

Co-C (1324 ºC) ingots

claire.elliott@npl.co.uk

Integrated thermocouples

claire.elliott@npl.co.uk

Integrated thermocouples

claire.elliott@npl.co.uk

Integrated thermocouples

EMPRESS
TEMPERATURE METROLOGY FOR PROCESS EFFICIENCY

Aim 1: Build and test an alumina thermocouple design, with an integrated reference ingot – without changing the external size

Lab testing

Aim 2: Test for up to 6 months at

ICPE-CA (Romania) and AFRC (here!)

NPL National Physical Laboratory | UNIVERSITY OF CAMBRIDGE | CCPI Europe Limited | BRML | PTB Physikalisch-Technische Bundesanstalt Braunschweig und Berlin | AFRC ADVANCED FORMING RESEARCH CENTRE UNIVERSITY OF STRATHCLYDE

claire.elliott@npl.co.uk

Integrated thermocouples

ICPE-CA (Romania)

- Through BRML

claire.elliott@npl.co.uk

Integrated thermocouples

ICPE-CA (Romania)

- Through BRML

claire.elliott@npl.co.uk

Integrated thermocouples

AFRC

claire.elliott@npl.co.uk

Integrated thermocouples

AFRC

claire.elliott@npl.co.uk

Summary

Ultra-stable MIMS thermocouples, manufactured, tested and set up at AFRC

Aiming to test for up to 6 months at Bodycote (UK & Romania)

claire.elliott@npl.co.uk

Summary

Ultra-stable MIMS thermocouples, manufactured, tested and set up at AFRC

Aiming to test for up to 6 months at Bodycote (UK & Romania)

Developed integrated thermocouples, within 7 mm OD sheath and started industrial trials

claire.elliott@npl.co.uk

Summary

EMPRESS
TEMPERATURE METROLOGY FOR PROCESS EFFICIENCY

Ultra-stable MIMS thermocouples, manufactured, tested and set up at AFRC

Aiming to test for up to 6 months at Bodycote (UK & Romania)

Developed integrated thermocouples, within 7 mm OD sheath and started industrial trials

Thank you for your attention

NPL National Physical Laboratory | UNIVERSITY OF CAMBRIDGE | CCPI Europe Limited | BRML | PTB Physikalisch-Technische Bundesanstalt Braunschweig und Berlin | AFRC ADVANCED FORMING RESEARCH CENTRE UNIVERSITY OF STRATHCLYDE

claire.elliott@npl.co.uk

EMPRESS
TEMPERATURE METROLOGY FOR PROCESS EFFICIENCY

NPL National Physical Laboratory
UNIVERSITY OF CAMBRIDGE
CCPI Europe Limited
BRML
PTB Physikalisch-Technische Bundesanstalt Braunschweig und Berlin
AFRC ADVANCED FORMING RESEARCH CENTRE UNIVERSITY OF STRATHCLYDE

claire.elliott@npl.co.uk

Brief introduction

Reference Temperatures – “fixed-points” on the ITS-90

claire.elliott@npl.co.uk