Introducing High-Temperature Hyperspectral Electronics to the Foundation Industries

Prof. Jon Willmott

Yufeng Lai, Callum Fisk, Hazem Zied

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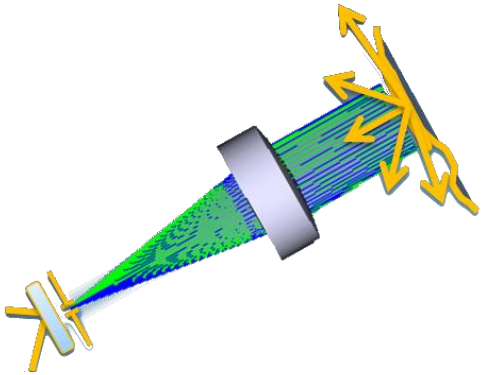
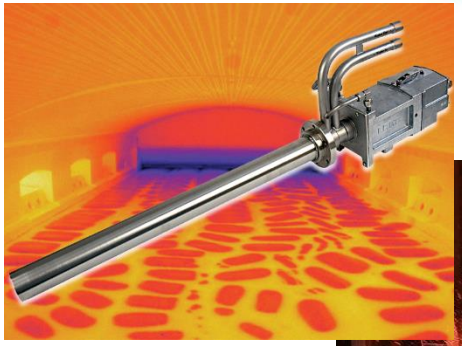


Sensor Systems Research Group
Department of Electronic and Electrical Engineering
University of Sheffield

A bit about my background…….

- 10 years optoelectronics designer
- EPSRC Established Career Fellowship (2015 2020)
- Currently Professor of Metrology



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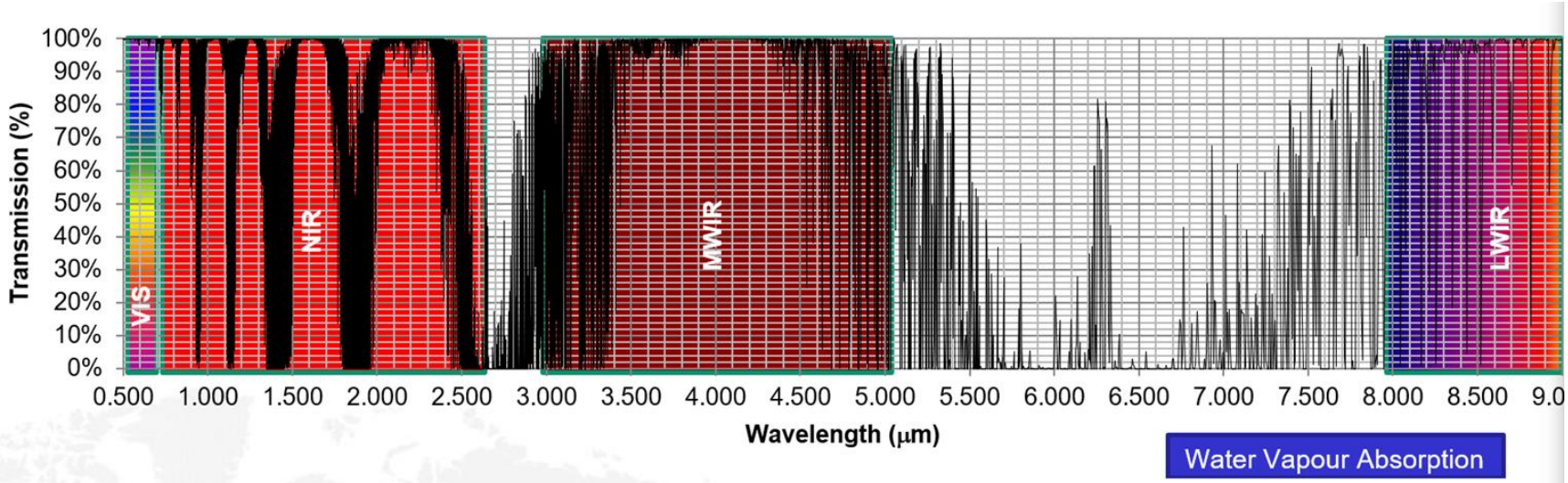
Outputs Network+ Project

- Mid-Wave Infrared Spectrometer
- Emissivity spectrometer algorithm
- Hyperspectral test results on BF metal samples
- Hyperspectral test results on flames



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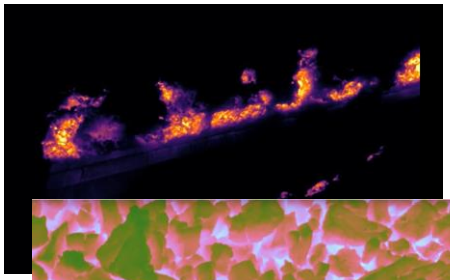
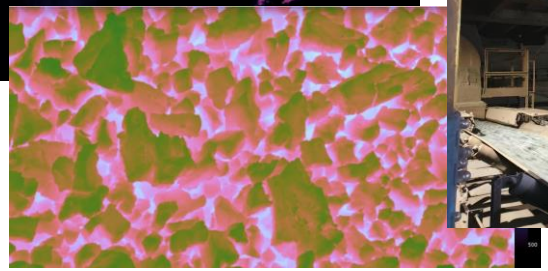
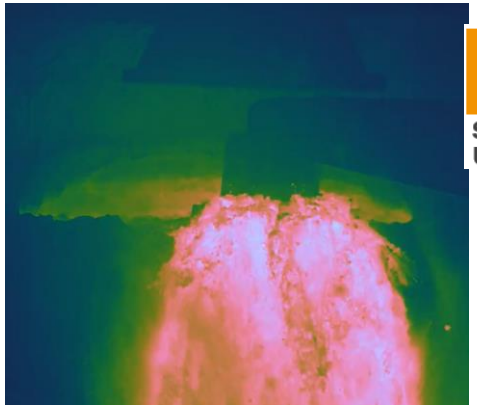
Metrology in Iron Making

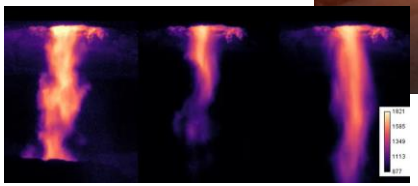
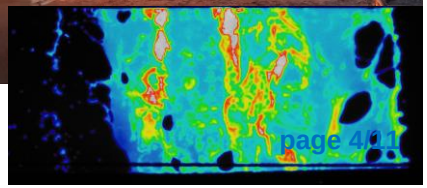






PyrOptik

SPIN-OUT FROM SHEFFIELD UNIVERSITY FOUNDED 2019

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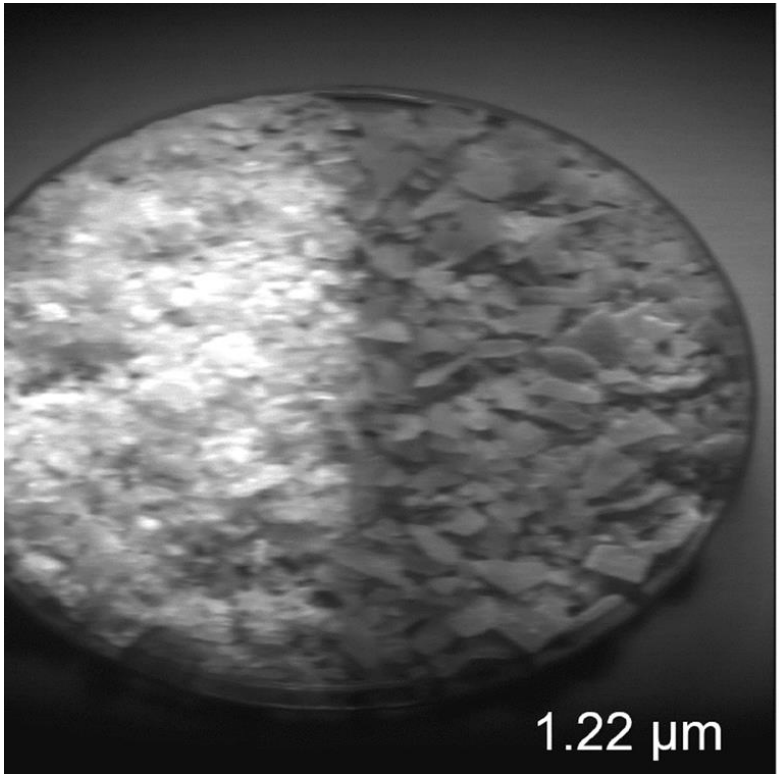
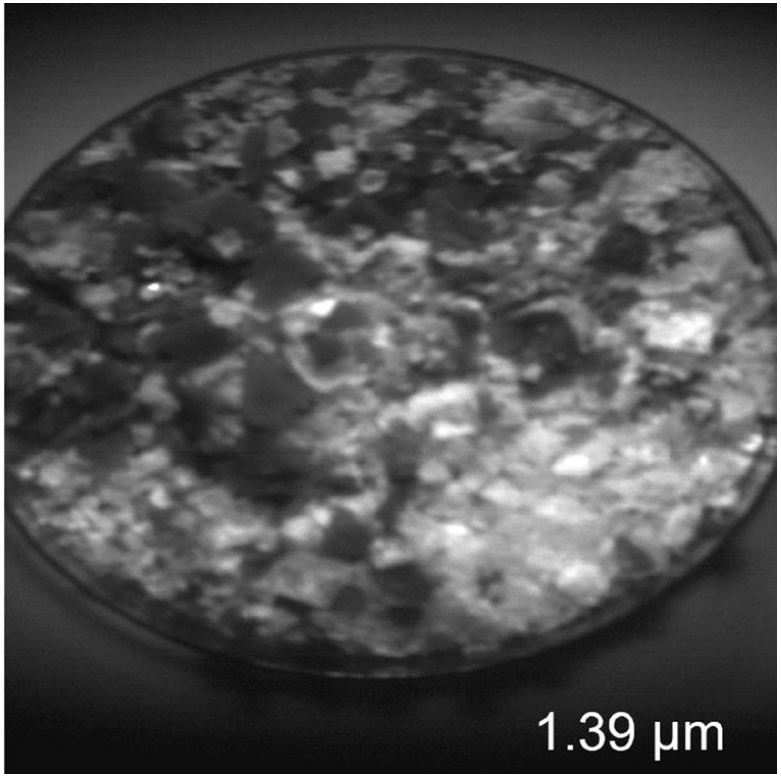
Hyperspectral Imaging





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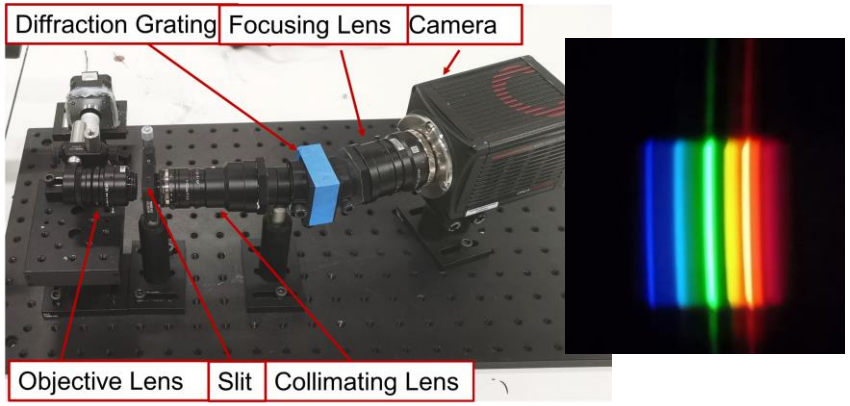
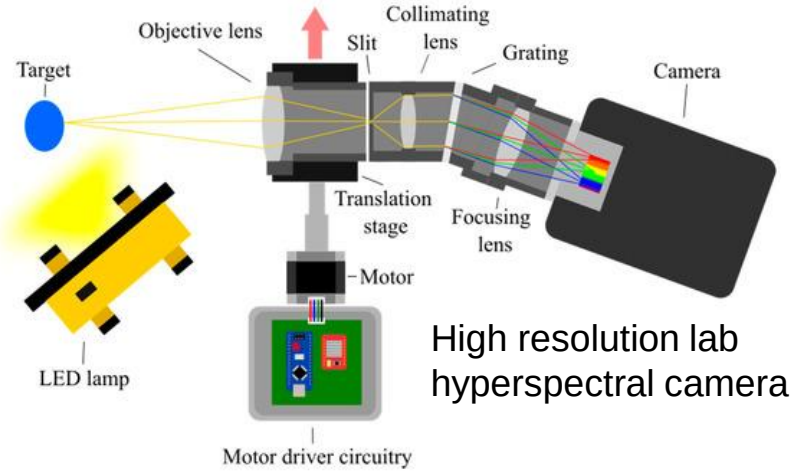
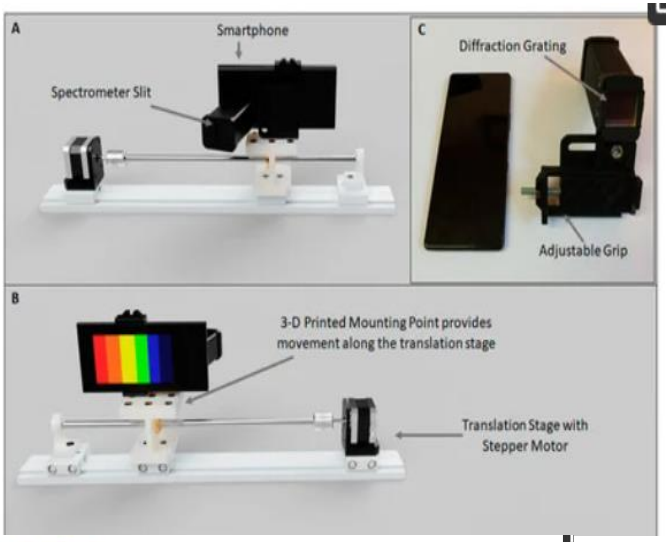
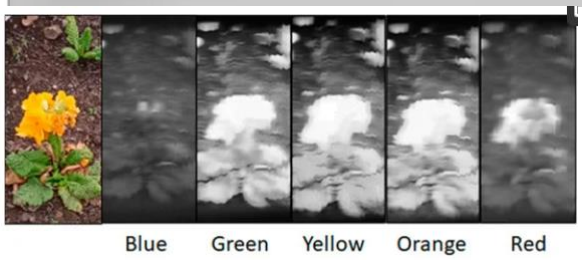
Hyperspectral Imaging





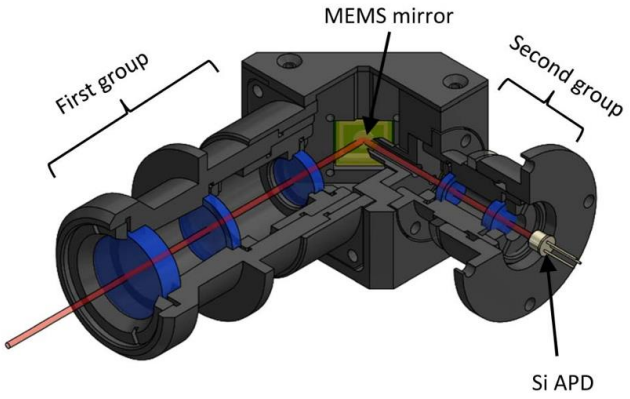
High resolution lab hyperspectral camera

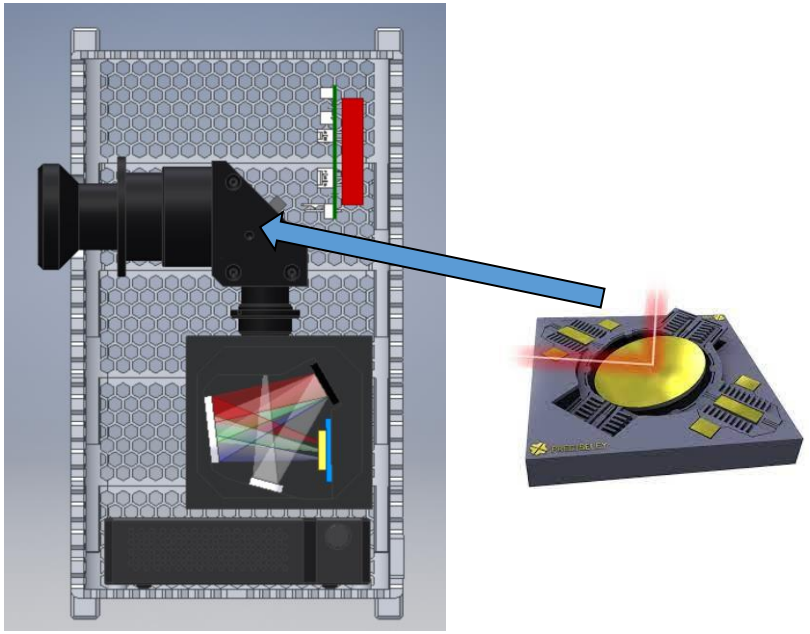




Mobile phone hyperspectral camera

“Staring” Hyperspectral Imaging





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Low Cost MWIR Hyperspectral Imaging

SLA64 PRELIMINARY

Silicon Based Thermopile Detector

Features: A 1 x 64 element silicon-based thermopile array. Each active area is 0.45mm x 2.0mm with a time constant of 42ms and a low Temperature Coefficient of Responsivity of -0.06%/℃. It is packaged in a 68-p in QIP. Includes internal 30kΩ 5% NTC chip thermistor provides ambient package temperature measurement. *See* Thermistor Options p/n: MT04.

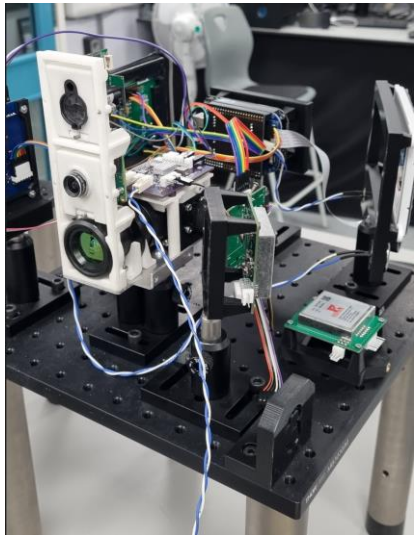
Options: Please contact Dexter's sales team for information on optical window options.

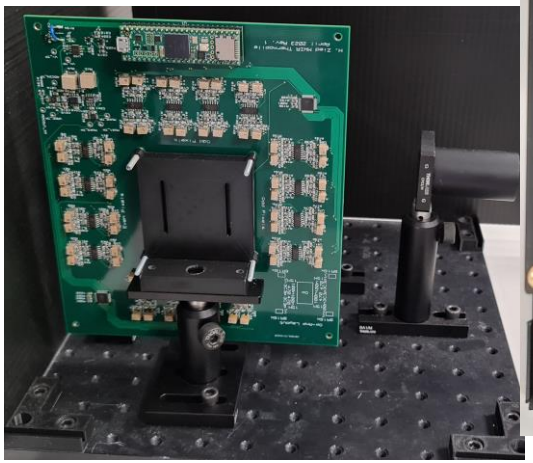
Applications: Spectral analysis and line temperature measurements.

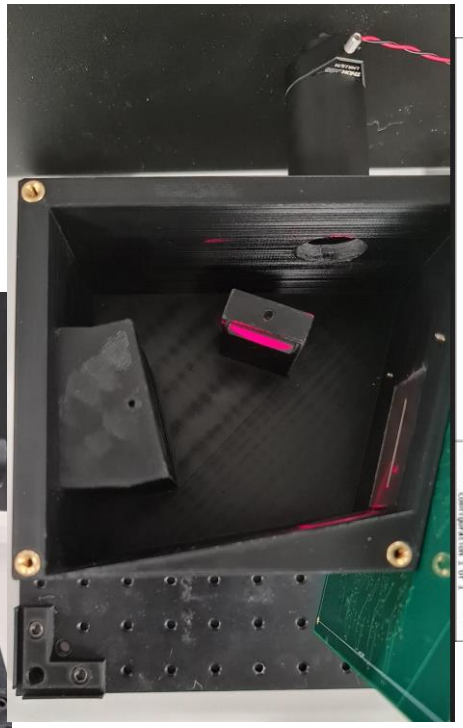
Benefits: A linear array with large element size and no readout electronics.

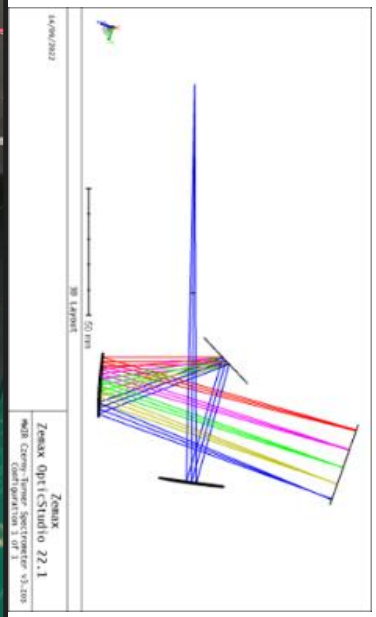
Detector circuit overlay

SLA64









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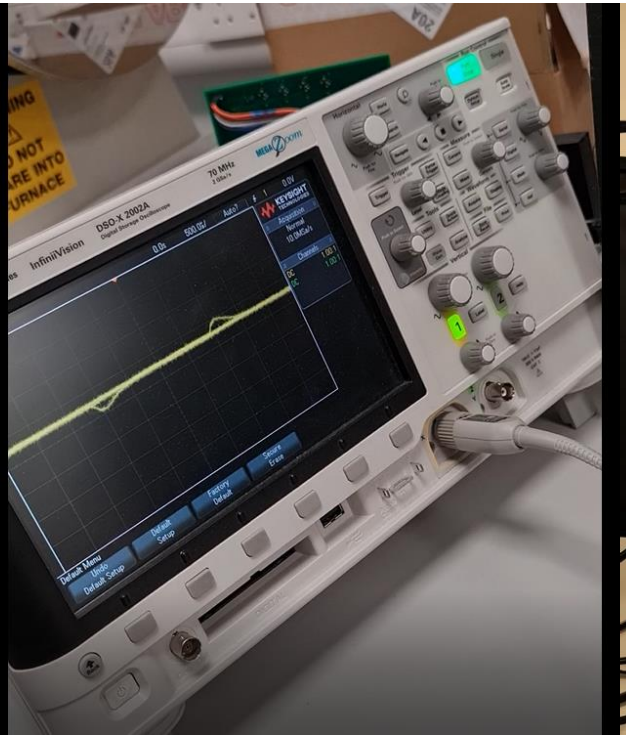
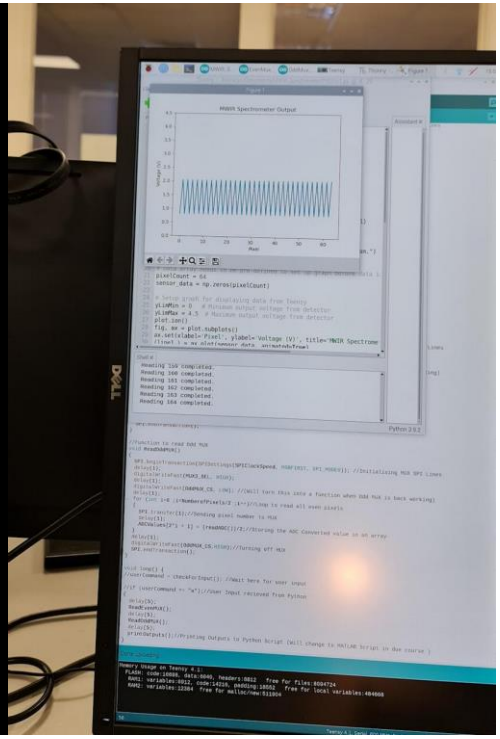
Low Cost MWIR Hyperspectral Imaging





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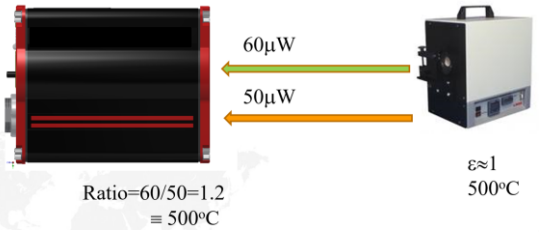
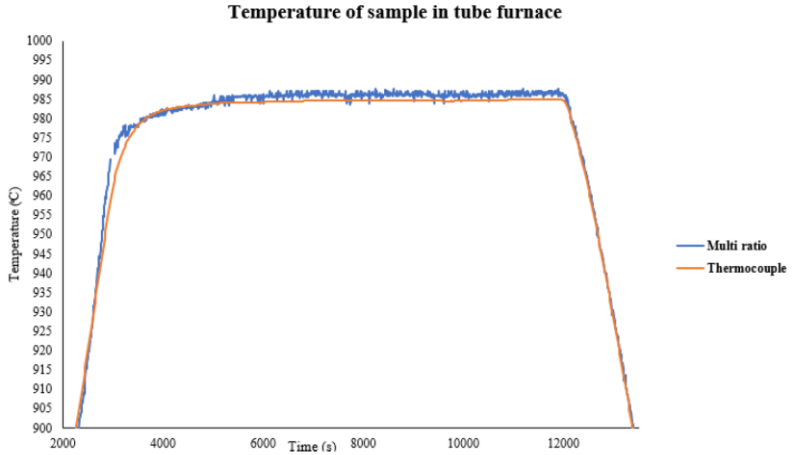
NIR Results: BF Iron

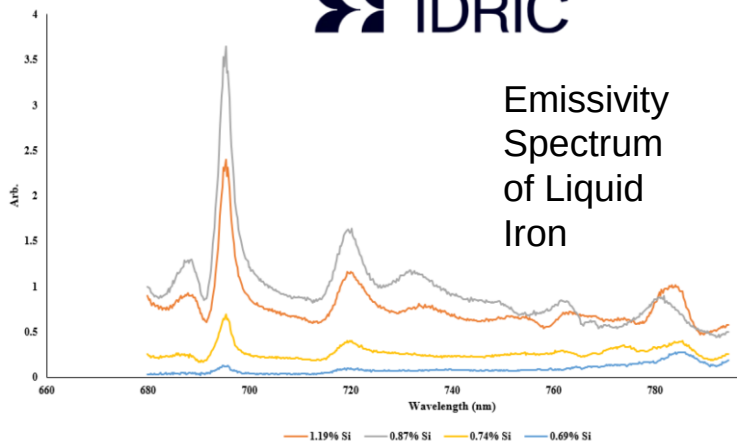
Ratio Thermometer

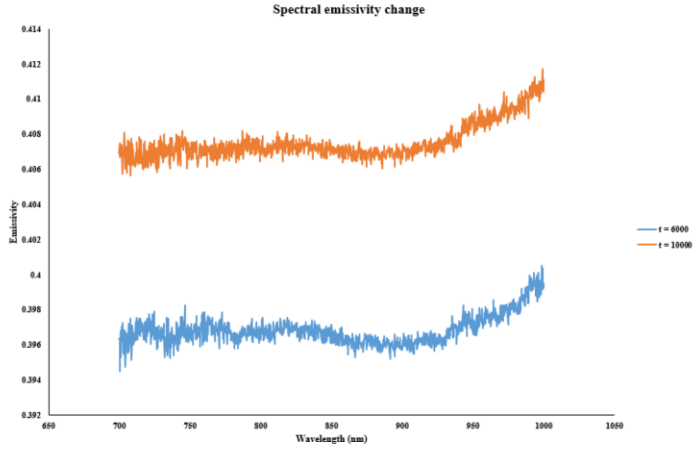




IDRIC

Emissivity Spectrum of Liquid Iron





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Hyperspectral imaging of Methane flames

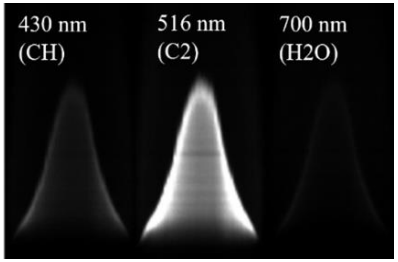
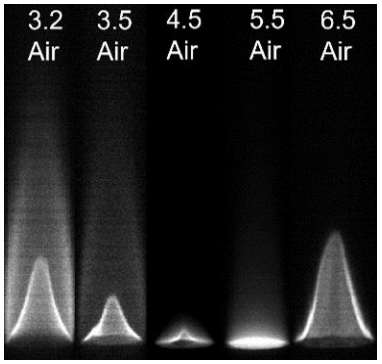


Figure Hyperspectral images of methane-air flame at certain wavelengths.



516 nm

Figure Example methane flames with different equivalence ratios.

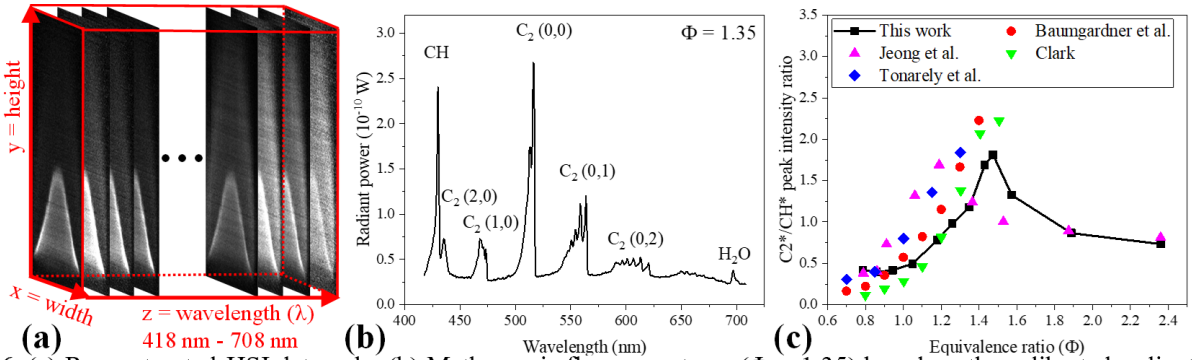


Fig. 6. (a) Reconstructed HSI data cube (b) Methane-air flame spectrum (Φ = 1.35) based on the calibrated radiant power (c) C_2*(0,0)/CH* peak intensity ratios against equivalence ratio, compared with other work.

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Hyperspectral imaging of flames

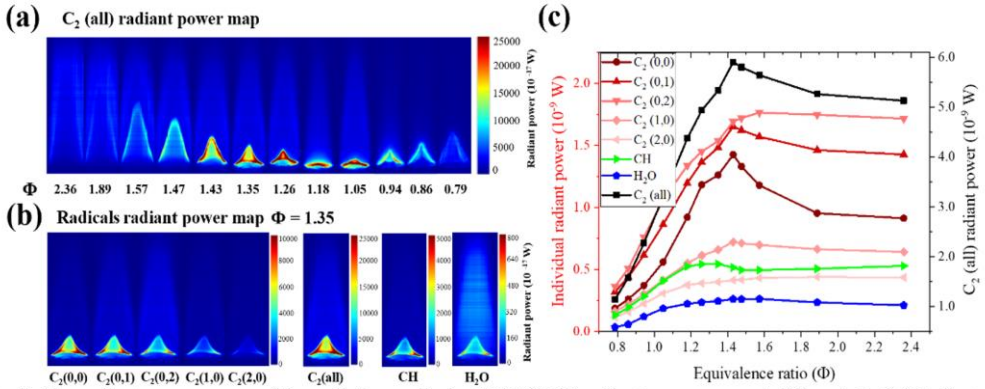


Fig. 8. The radiant power maps of the radiating radicals. (a) C_2* (all) radiant power map at different Φ. (b) Radiant power map of different radicals at Φ = 1.35. (c) The radiant power of the different radicals integrated along segmented flame profile.

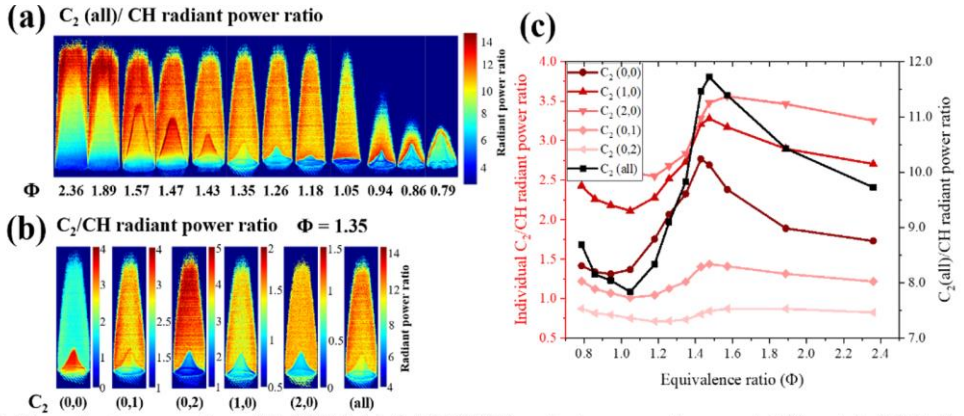


Fig. 9. The radiant power ratios of C_2*/CH*. (a) C_2* (all)/CH* radiant power ratio map at different Φ. (b) Radiant power ratio map of different C_2* radicals against CH* at Φ = 1.35. (c) The radiant power ratios of varied C_2* /CH* of the flame.

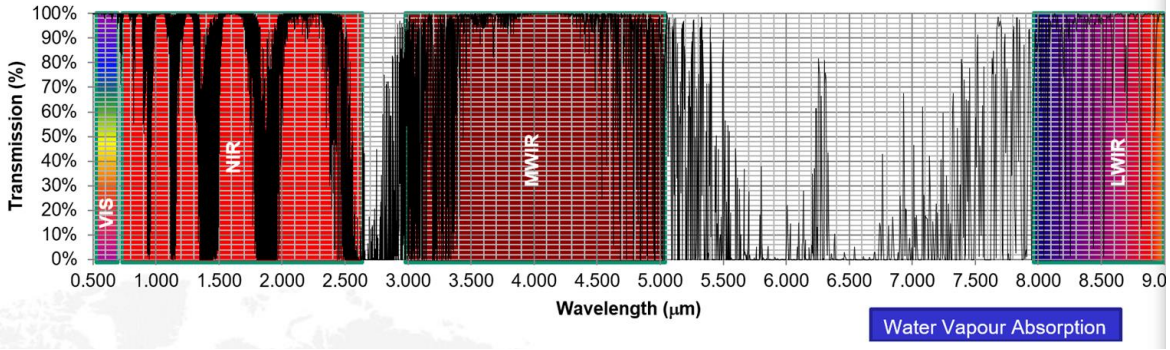
Milan 2024
CI'S 40th
INTERNATIONAL SYMPOSIUM
Emphasizing Energy Transition
21st- 26th JULY, 2024

TATA STEEL

Achievements so far….

- Mid-Wave Infrared Spectrometer
- NIR Hyperspectral test results on metal IDRIC
- NIR hyperspectral test results on flames TATA STEEL
- Further funding from the “Industrial Decarbonisation Research and Innovation Centre” and TATA
- Submitted paper to 40th International Combustion symposium:

“Spectral and Spatial Visualisation of Radiant Power Emitted by Hydrocarbon Flames Using a Calibrated Hyperspectral Imaging System”



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