Coke Characterization:
Thermogravimetric and Spectroscopic Analysis

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Introduction

- Coke is a porous material produced from coal, with a higher carbon content and fewer impurities, used mainly as a support in iron production. It is produced by heating metallurgical coal to high temperatures in the absence of oxygen [1,2].
- Coke characteristics and quality affect performance in the blast furnace and the quality of the iron.
  - Weight loss when reacting with CO_2 at high temperatures should be low [1].
  - Total porosity is low in strong cokes [3].
  - The content of graphitic carbon compared to disoriented carbon is generally higher in a good coke [4].
- The objective of this research is to characterize various coke samples. In broad, this is done in order to screen coke quality on a smaller scale and in a more cost effective manner than industrial scale testing.

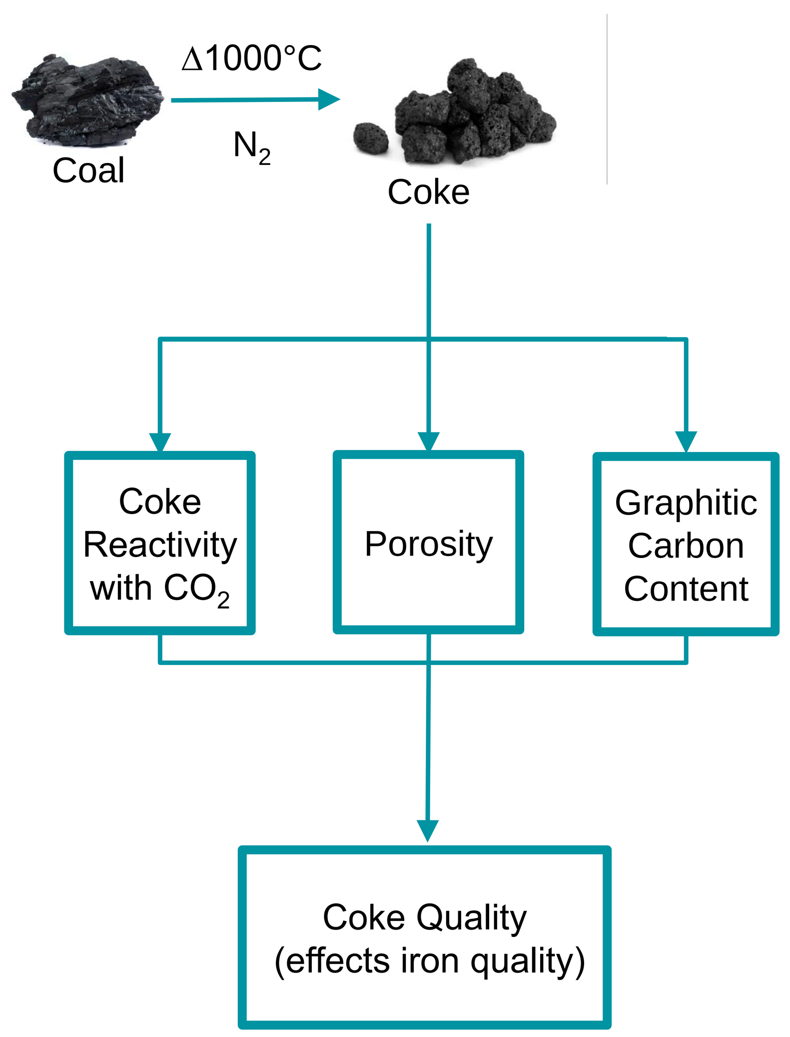

Figure 1: Coke characterization

Methodology

Thermogravimetric Analysis

- In order to study the weight loss behaviour of coke, thermogravimetric analysis (TGA) was carried out with CO_2 at 1100°C for 2 hours.
- From the TGA plot, weight loss over time was observed and total weight loss was calculated.

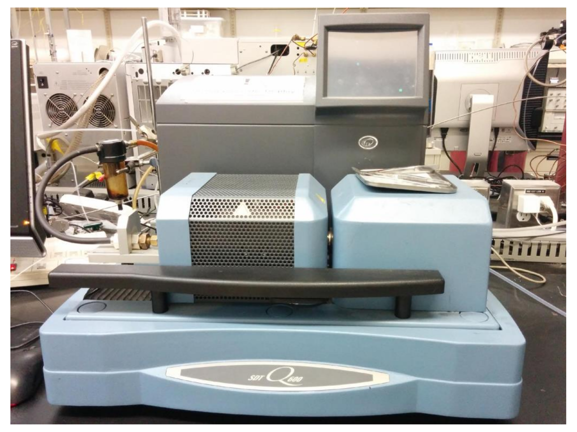

Figure 2: TGA SDT Q600 instrument

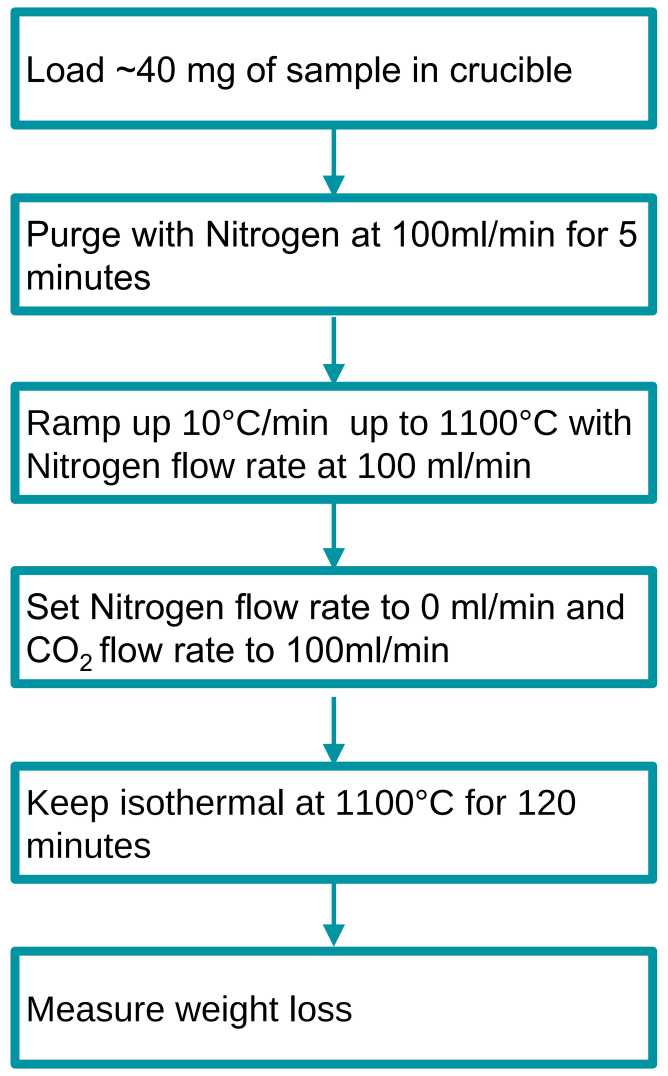

Figure 3: TGA experimental procedure

Raman Spectroscopy

- Raman Spectroscopy was used to observe the inelastic scattering of light from the sample's molecules.
- The contents of graphitic carbon and disoriented carbon were compared.

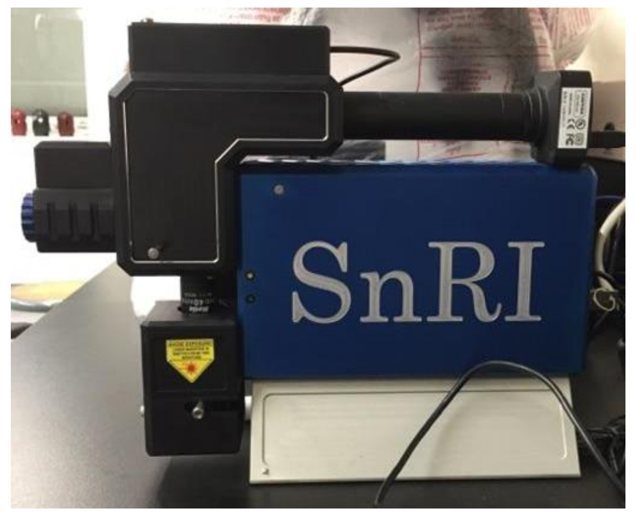

Figure 4: Raman Spectroscope

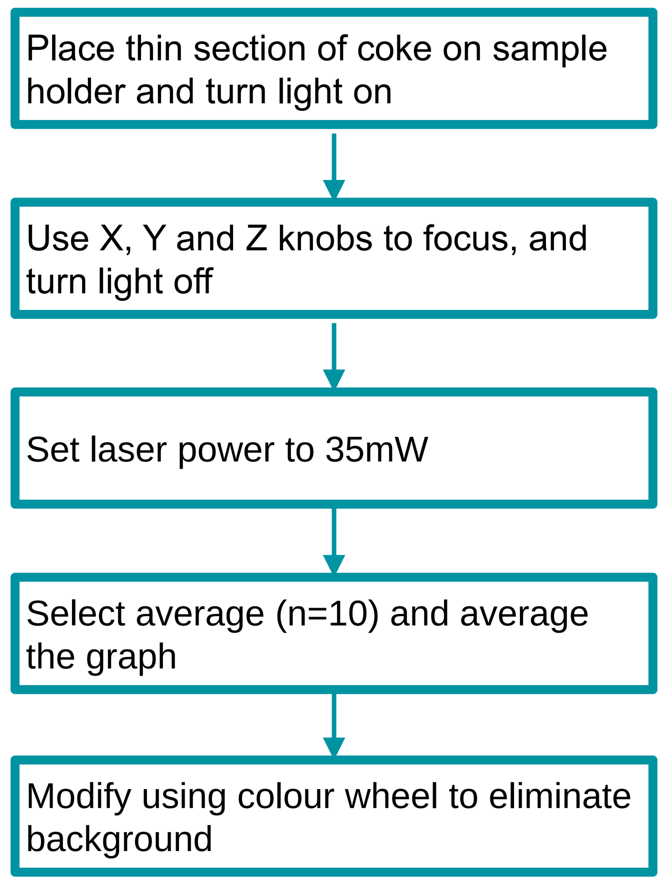

Figure 5: Raman Spectroscopy procedure

Results

CO_2 Gasification Mass Vs Time Plot

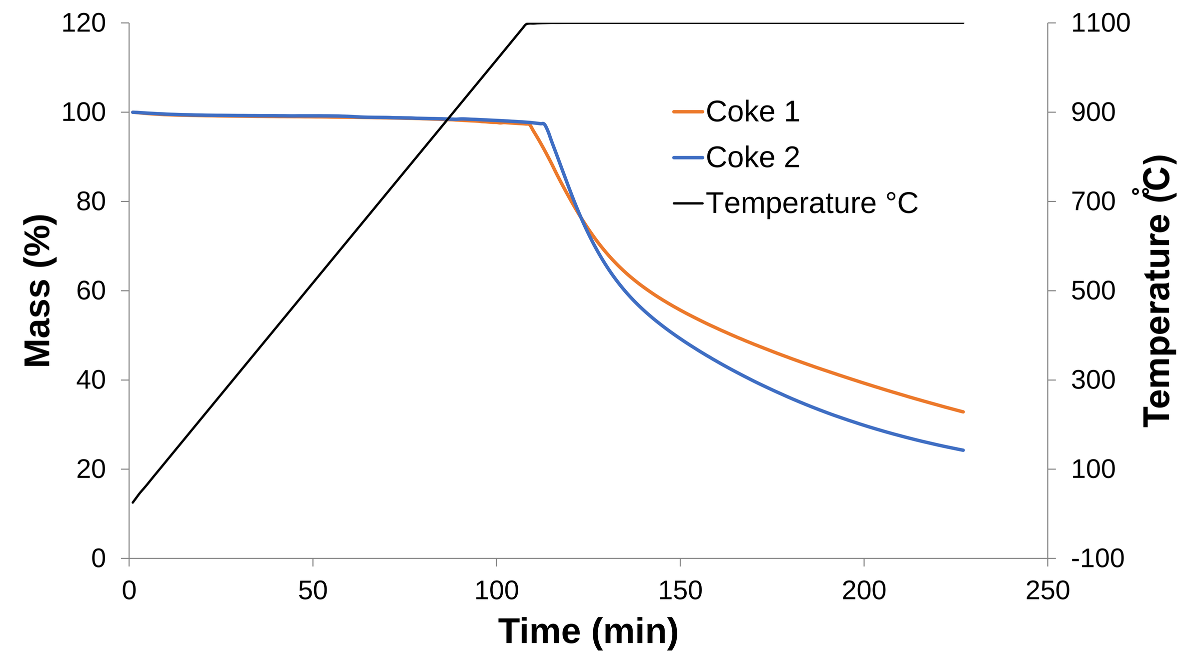

Figure 6: TGA plot of weight loss behaviour while reacting with CO_2

Sample	Total mass loss (%)	Mass loss (%) during isothermal period at 1100̊C
Coke 1	67.5	75.3
Coke 2	75.8	88.7

Coke 1 lost less mass, and mass loss was slower than coke 2.

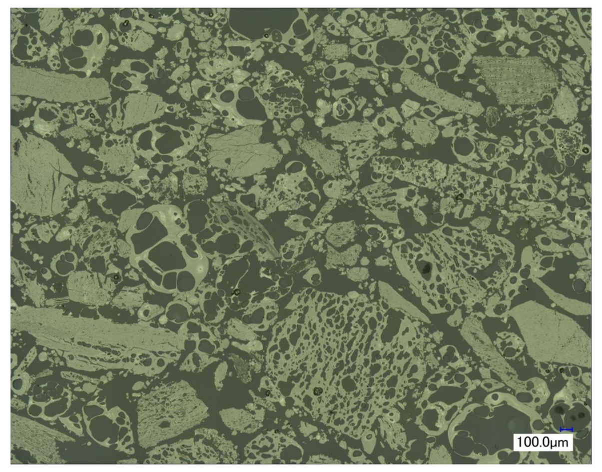

Figure 7a: Microscope image of coke 1 (25X magnification)

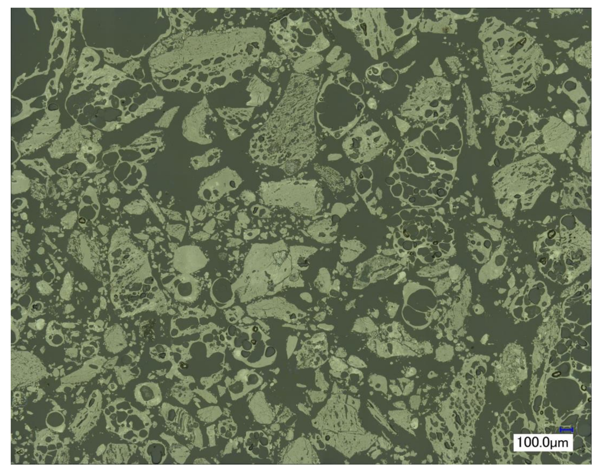

Figure 7b: Microscope image of coke 2 (25X magnification)

Porosity

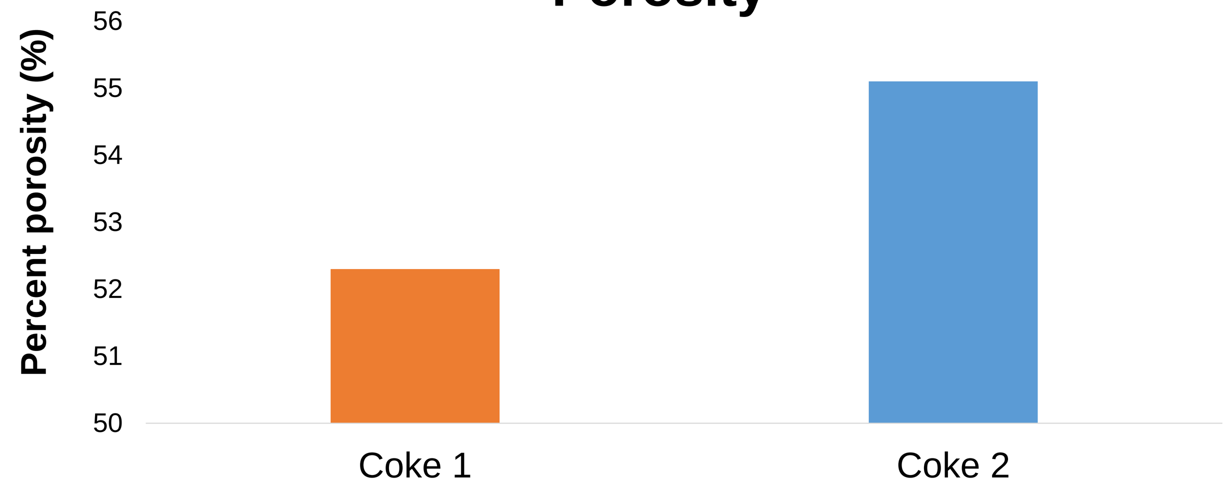

Figure 8: Percent porosity of samples

Coke 1's total porosity is less than that of coke 2.

Raman Spectra

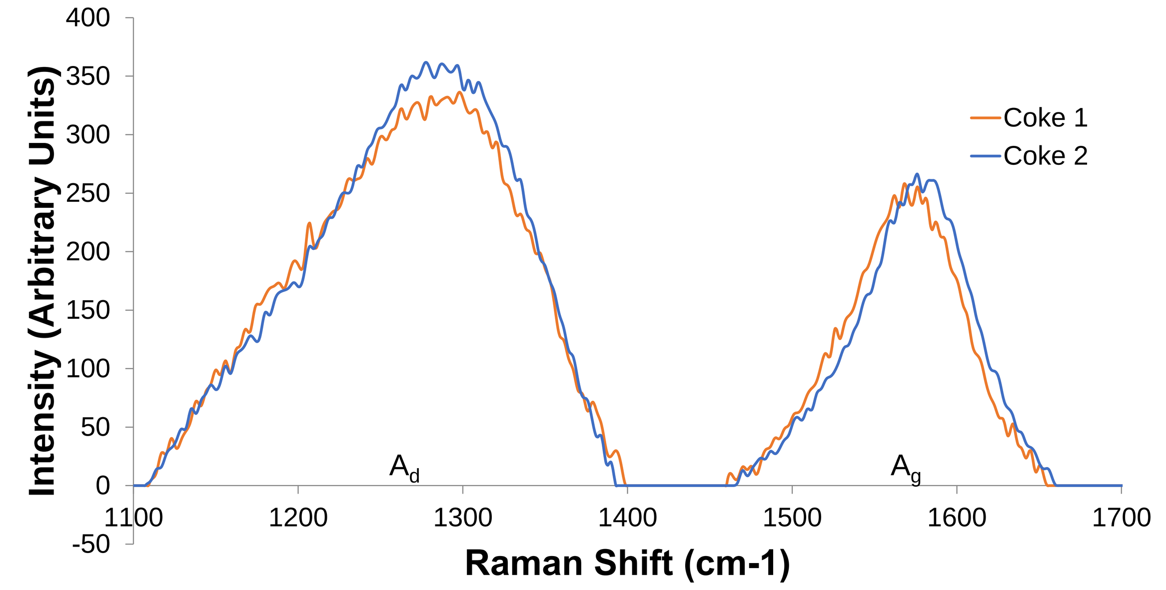

Figure 9: Raman spectra of samples showing disoriented and graphitic carbon

Sample	Area under Disoriented Carbon Peak (A_d)	Area under Graphitic Carbon Peak (A_g)	Ratio of Graphitic Carbon ($A_g/(A_d+A_g)$)
Coke 1	54352	22359	0.291
Coke 2	55914	22231	0.284

Coke 1 has a higher graphitic carbon content compared to the total carbon than coke 2.

Conclusions

- Coke 1 lost less mass, and mass loss was slower than coke 2 when reacting with CO_2 (at 1100°C for 2 hours).
- Coke 1 has a higher graphitic carbon content than coke 2.
- Coke 1 is less porous than coke 2.
- Coke 1 is a higher quality coke than coke 2 as it is less reactive with CO_2, a lower porosity and has a higher graphitic carbn content.

Acknowledgements

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References

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