X-ray Raman scattering for the study of hydrothermal carbon materials

L. Higgins, A. Brown, A.B. Ross, B. Mishra

School of Chemical and Process Engineering, University of Leeds, Leeds, UK LS2 9JT; **pmljrh@leeds.ac.uk**

X-ray Raman Scattering (XRS) is non-resonant inelastic X-ray scattering from core electrons [1]. This technique gives access to soft X-ray absorption edges (e.g. C, N, O) using hard (e.g. 10 KeV) X-rays as the probe. The use of hard X-rays increases the penetration depth from a few tens of nanometers to the order of millimetres, allowing for complex sample environments and bulk material analysis [2]. Here, this emerging synchrotron radiation technique is applied to hydrothermal carbon produced by the decomposition of biomass (Oak wood) under hot-compressed conditions [3]. Despite a wide number of applications (e.g. supercapacitors, renewable fuels), very little is known about the structure and reaction mechanisms responsible for hydrothermal carbon formation. Previously, bulk evidence of carbon speciation for these materials has only been possible using advanced solid-state NMR techniques. However, these techniques have challenges such as low signal to noise ratios and poor resolution of certain carbon environments [4]. Here XRS is applied to better describe the structure of hydrothermal carbon and put it in relationship with more classical pyrolytic carbons (pyrochar). This study offers insight into whether calcined hydrothermal carbon is equivalent to its pyrolytic equivalent and offers an-depth understanding of the reaction mechanism. A molecular understanding of these sustainable carbon materials will allow them to be chemically modified for specific applications such as toxic metal remediation [5].

References

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