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The Henry Moseley X-Ray Imaging Facility

Development of the rapid Tomographic Energy Dispersive Diffraction Imaging system (rTEDDI)

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In 1998 a new tomographic technique named TEDDI (Tomographic Energy Dispersive Diffraction Imaging) was developed by Hall *et al* [1] based on the work of Harding *et al* [2]. The TEDDI technique takes advantage of the multi-wavelength information contained in the diffraction pattern created from a bulk sample being exposed to "`white beam"' X-rays (See Fig 1). This allows structural and compositional information of the interior of a bulk sample to be collected non-destructively. This makes it potentially of great use when identifying tissue types [2]; for airport security or for identifying strain variations in crucial engineering components [3].

The TEDDI experimental setup

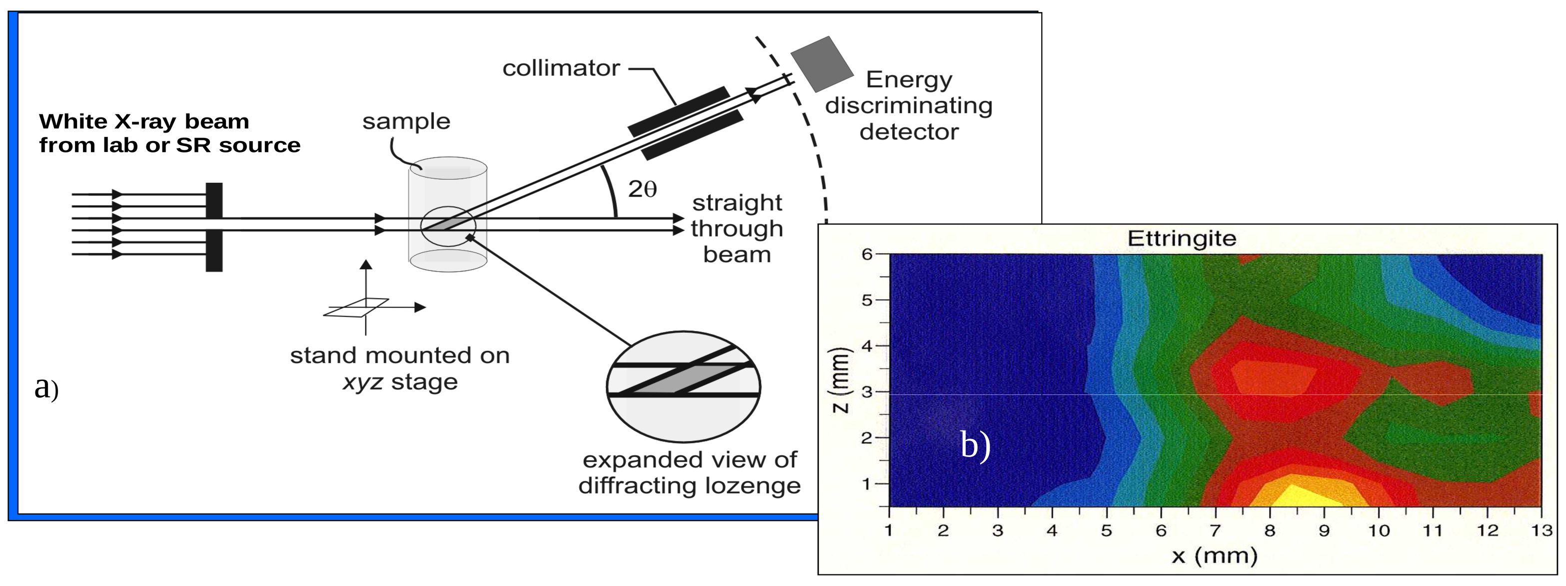
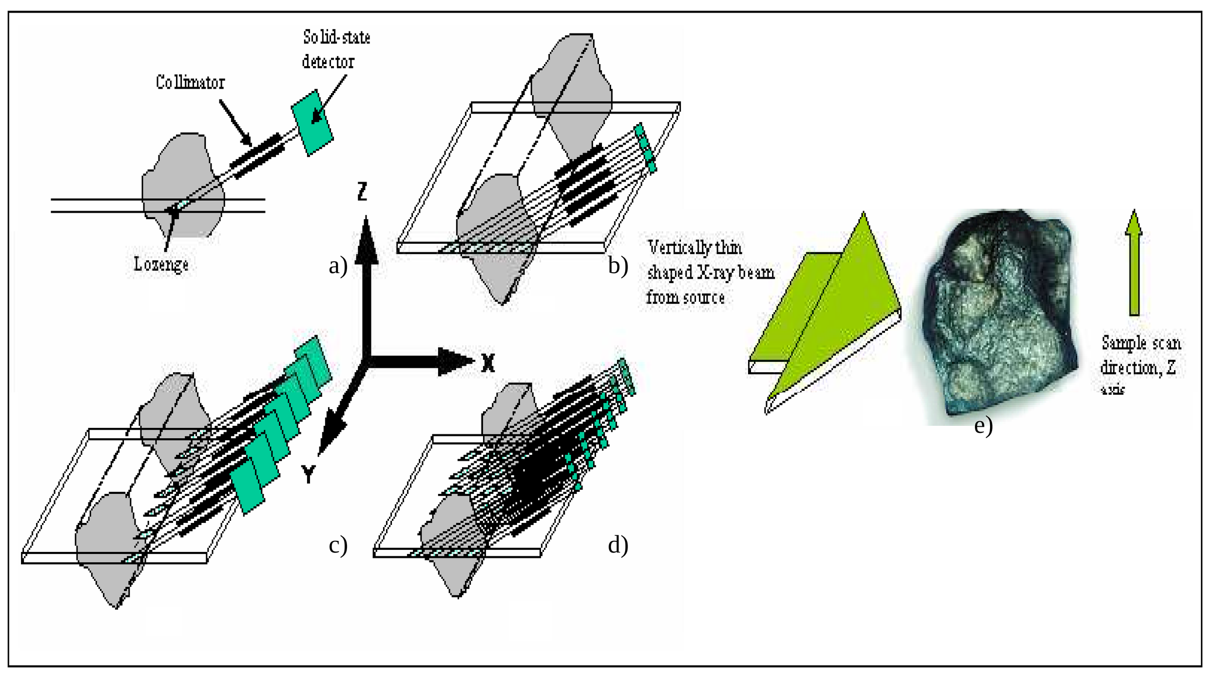


Fig 1. a) Illustration of the basic geometry of the TEDDI setup. b) 2D cross-sectional slice within a concrete block collected by the TEDDI system - showing aggregate (blue) and cement phases (green /red/yellow) [5].

The basic setup of the TEDDI imaging technique can be seen in Fig. 1a. A white X-ray beam penetrates a sample. A collimator and an energy resolving detector is set at an angle. The intersection of the X-ray beam and the field of view of the collimator creates a lozenge within the bulk of the sample that is imaged by the collection of the volumes diffraction pattern. By step-scanning the lozenge through out the sample 2D maps, such as the one seen in Fig. 1b., can be obtained.

The need for the rapid TEDDI experimental setup



The main drawback of the TEDDI technique is the long exposure times needed, usually 16-20 hrs using point by point scanning, in order to build up a 2D image of a bulk sample. To overcome this drawback the rapid TEDDI (rTEDDI) system has been developed [4] at the University of Manchester's School of Materials. The working principal can be seen in the figure above. By creating an array of collimators and detectors an entire plane could be imaged at once.

Proof of Concept

By coupling a pixelated energy resolving detector [6] to a specially manufactured collimator array [7], where each collimator had an aspect ratio of 6000:1, the rTEDDI system was realised. A proof concept for the system has successfully been carried out using thin metal, polymer and organic samples being exposed to a white X-ray beam from a synchrotron source. Cu and Al peaks have been determined to a three decimal point accuracy showing the potential of the method for strain scanning. A polymer nylon-6 sample containing a set of geometric test structures, as seen in Fig 2. was successfully identified and imaged. The structure of hydroxyapatite was identified and refined from a deer antler bone sample [8]

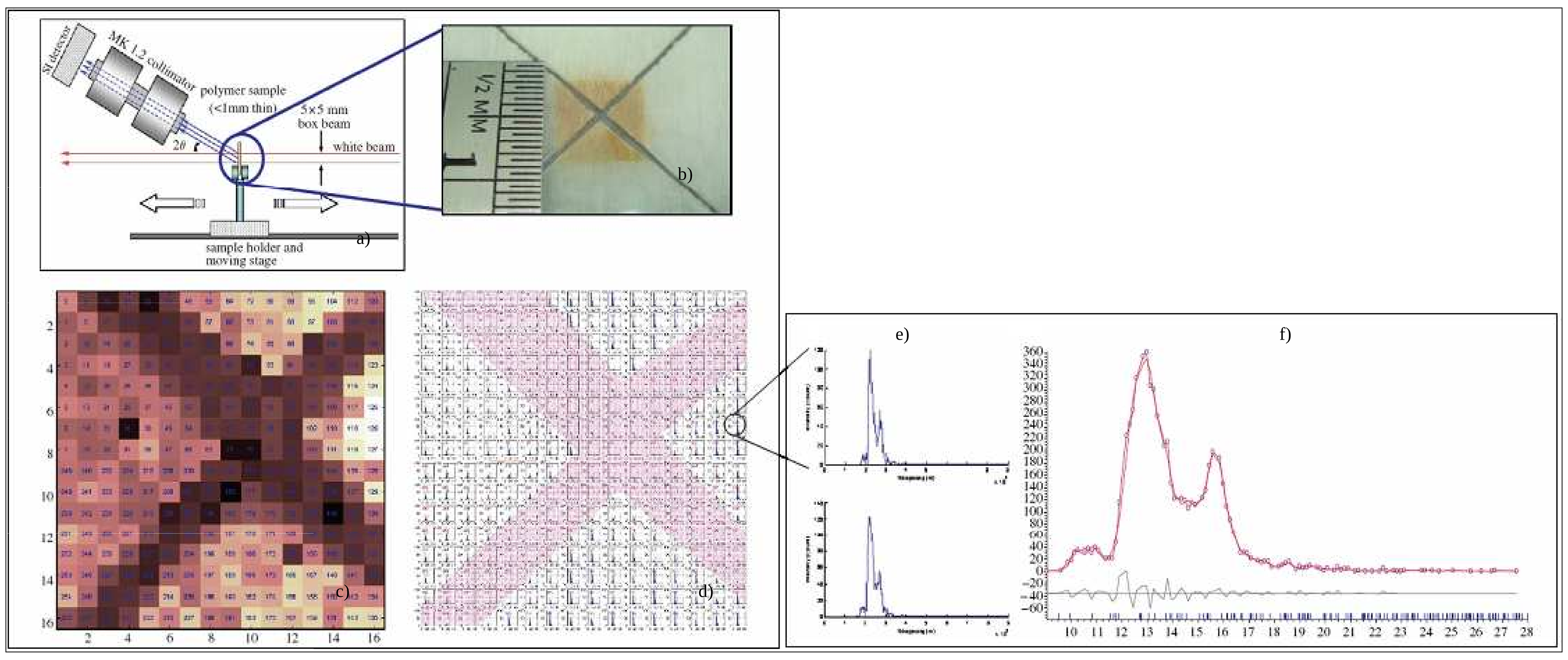


Fig 2 a) Illustration of the rapid TEDDI experimental setup with the polymer sample marked out. b) Picture of the polymer sample with the test X structure clearly visible. c) Pixel intensity map of the polymer sample showing the imaging capability of the rapid TEDDI technique. d) Pixel diffraction map of the polymer sample. Each pixel diffraction originates from a different spatial region of the sample. e) Blown up view of the diffraction pattern from two of the pixels in the pixel diffraction map. f) A lattice parameter refinement of the polymer nylon-6 test sample. [9]

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Acknowledgements

We would like to thank EPSRC and STFC for research support and access to research facilities. This work was motivated by the HEXITEC collaboration <www.hexitec.co.uk>

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