A variety of magnetic signals are sensitive to stress, and many of these are also sensitive to microstructure. By combining information from a range of signals it is possible to deduce - non-destructively - the in-plane stresses and their orientations in magnetic materials. Altering the search frequency allows scanning from near the surface to depths of approximately 10 mm.

**FACILITIES**

- MAPS (Magnetic Anisotropy and Permeability System). This equipment is shown above. Spatial resolution: 5.2 and 15.5 mm, depending on probe type, to a depth of 0.1 to 5 mm.
- MARSH (Magneto Acoustic Residual Stress & Hardness System), with a Barkhausen noise probe. Resolution of MARSH: 17 mm to a depth of 0.1 to 10 mm, and for Barkhausen: 12 mm to a depth of 20 to 300 mm.

Both are AEA Technology instruments. MAPS is a quick method, requiring under 2 minutes to make a bi-axial stress measurement, and is also a portable system. Marsh and Barkhausen noise are laboratory based techniques.

All ferromagnetic materials can be examined, including ferritic steel, cast iron, tool steel, some stainless steels and nickel super-alloys.

Each system enables several magnetic parameters to be measured. Complementary information allows a wide range of materials to be examined, and minimizes microstructural constraints. The table at the bottom of the page gives an indication of the sensitivity of the available techniques.

**CASE STUDY – RESIDUAL STRESSES IN A SECTION OF TRAIN RAIL.**

MAPS was used to make the following stress maps from a section of train rail.

<table>
<thead>
<tr>
<th>Coercivity</th>
<th>Hysteresis loss</th>
<th>Remanence</th>
<th>Field strength</th>
<th>Permeability</th>
<th>Barkhausen emission</th>
<th>Magneto acoustic emission</th>
<th>Impedance Coercivity</th>
<th>Stress induced magnetic anisotropy</th>
</tr>
</thead>
<tbody>
<tr>
<td>High microstructural sensitivity</td>
<td>High stress sensitivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
These three stress plots are courtesy of Dr D Buttle, AEA Technology.

For more information on Magnetic Methods for Stress Measurement contact:
Prof. Phillip Withers — phillip.withers@manchester.ac.uk — Tel: 0161 306 8872

Materials Science Centre, University of Manchester, Grosvenor Street, Manchester, M1 7HS