

## Project A6: Three-Dimensional Microstructural Modelling Of Crack Initiation In Rail Steel

### Partners

University of Birmingham - Metallurgy & Materials  
Newcastle University – Mechanical & Systems Engineering

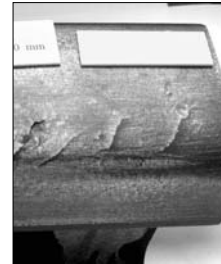
### Researchers

**Birmingham**

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**Newcastle**

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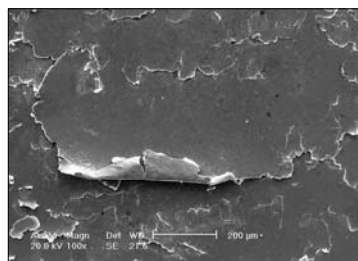


Visual appearance of rolling contact fatigue cracks (left). X-ray 3d imaging of a fatigued cracked rail (above).

### Aim

To provide guidance on rail microstructures capable of increased wear and fatigue life, more predictable operation, and lower maintenance requirements.

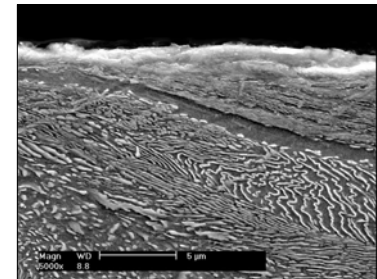
Engineering Interfaces



Surface flaking during laboratory testing of rail steel

### The origin of crack initiation

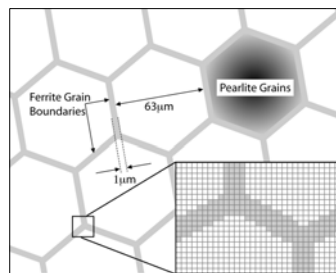
Rail surface cracks begin with microstructural deformation. To design out the problem in new steels the earliest stages of failure must be understood.



Deformed rail steel near the rail surface. Strain and compaction above the ferrite band appears greater than below it.

### Novelty & progress

New links are being made between high resolution microscopy observations, and models of steel failure. This will aid design of microstructures with greater failure resistance.



Microstructure represented by "bricks" with properties determined by materials testing & fundamental modelling

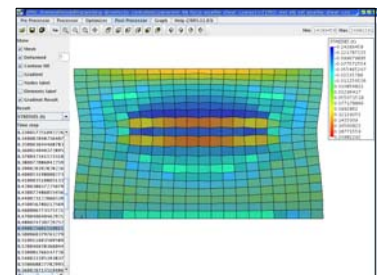
### Multi-scale modelling

Relating microstructural changes to macro scale cracking is accomplished with three scales of model:

- (i) Bulk material
- (ii) Multi-grain
- (iii) Sub-grain.

### Understanding rail failure mechanisms

At the microstructural level rail steel is a three dimensional composite of ferrite and cementite phases, plus non-metallic inclusions. Failure is dependent on how stress and strain are accommodated by these phases, inclusions and the bonds between them. This is being investigated at the sub-grain size level.



Elastic-plastic large strain deformation finite element study of the microstructure

### Further information

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