Scanning Force Microscopy

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Atomic, or Scanning Force Microscopy, is a surface examination technique using a mechanical tip in contact with a surface. The tip is attracted or deflected by surface features through interatomic forces.

The Problem

A number of welded P91 components have experienced premature failure, some after only 20,000 hours or less.

Replication and associated SEM examination does not show significant cavitation until late in life (above 70% of life), and spheroidisation does not occur in martensitic steels.

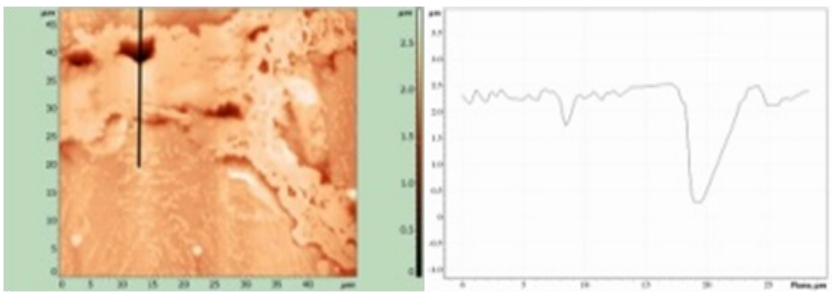
New NDE techniques needed to be developed to predict in-service component deterioration at a reasonably early stage in life.

The Solution

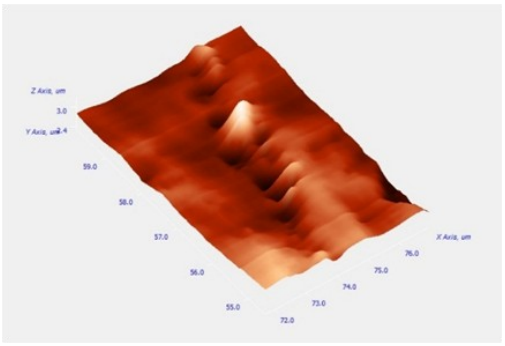
The development and use of a portable Scanning Force Microscope (SFM) for detection and study of early stage creep cavitation and damage at the nanometre scale. The SFM produces a 3D topographic map of the surface being examined.

The SFM can be used on almost any material, and can be mounted at any angle on the component being scanned.

Results



SFM image acquired after chemical etching of a P91 sample. The cross-section along the black line is on the right, highlighting the cavity in the image.



Three dimensional SFM image of creep cavitation in P91, aiding interpretation.

Advantages of an SFM

1. The surface preparation is the same as that for replication.
2. Unlike an optical or electron microscope, SFM scans in three dimensions which means that it can give details of surface roughness and cavity depth.
3. Cavity depth and volume can be measured.
4. The SFM can be used on-site, but images can be instantly transmitted to experts in the office, via the internet.

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