ESRF	**Experiment title:** **Residual stress concentrations around scratches in peened Ti-6Al-4V alloy**	**Experiment number:** **HS - 168**
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Report:

This proposal was for an allocation of time to measure the residual strain and stress distributions around scratches in a peened plate sample of Ti-6Al-4V, a material of generic aerospace engineering interest used for the large fan blades at the air intake of aeroengines. A potential failure mode of turbine blades is by fatigue cracking. Cracks may originate at a surface defect, about which there would be a stress concentration, and then propagate by fatigue, during service, until a critical length is reached after which fracture would occur. To combat this risk and to improve component lifetimes shot-peening, a process in which the surface is plastically deformed by bombardment with small shot, is used to generate a thin surface layer that is in compression, balanced by a tensile region at greater depths. The compressive layer inhibits the initiation and growth of surface cracks by fatigue, but if it is too thin the advantages can be offset by the increased risk of failure from sub-surface defects or from deeper scratches which may penetrate into the tensile stress field. It is vitally important, for both safety and economic reasons, for engineers to know the residual stress pattern produced by different peening processes and the depth of scratch that is 'safe' to tolerate before a blade has to be replaced.

In this experiment the residual stress distributions around four scratches on one side of a peened plate that has been peened to the standard most commonly employed by manufacturers of fan blades were mapped.

Four parallel scratches, each 4 mm apart, had been made, after peening, to depths of 50, 100, 150 and 200 μm, respectively. The scratches were scored under industry calibrated 'standard' conditions as it is known that the shape, in particular the sharpness, of a scratch will influence the local residual stress field. These particular scratch sizes were chosen as it was anticipated that the compressive zone produced by peening would extend to a depth of between 100 and 150 μm so that the tips of two shallowest scratches would be in the compressive zone but the deeper two would probably penetrate into the balancing tensile zone.

Figure 1 shows a map of peak position as a function of location for a two-dimensional scan from the surface to a depth of 300 μm over the region of the scratches which are located at 0, 4, 8 and 12 mm respectively. The scanning matrix is shown as an array of dots. The pattern clearly shows the locations of the scratches and the amplitude of the strain disturbance which increases with scratch depth. The darker shading represents in-plane compression and the light areas tension. In all cases there is an increase in tensile stress ahead of the scratch tip. It is low for the 50 μm scratch but is high and continues through to the surface for the 200 μm scratch. In the former case the peening effect has been beneficial but for the latter case it is probably detrimental.

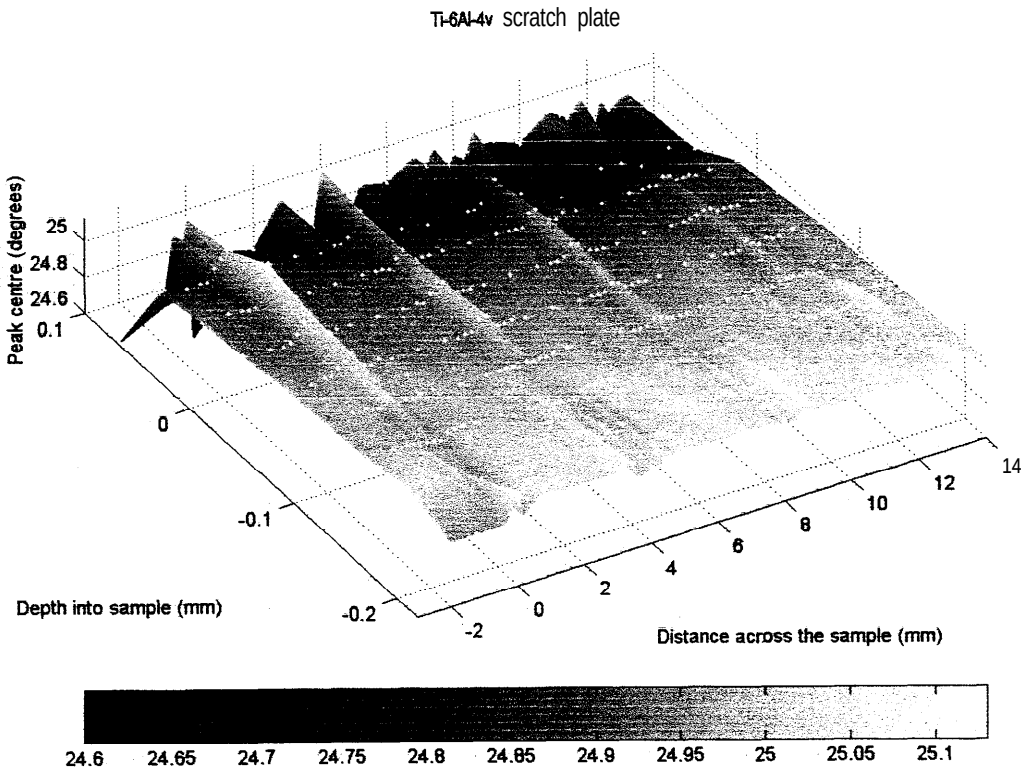

Figure I Peak position versus location indicating the residual strain field produced by 4 scratches of increasing depth in a peened surface.