Fatigue Characteristic of Linear Friction Welded Ti-6Al-4V Joints

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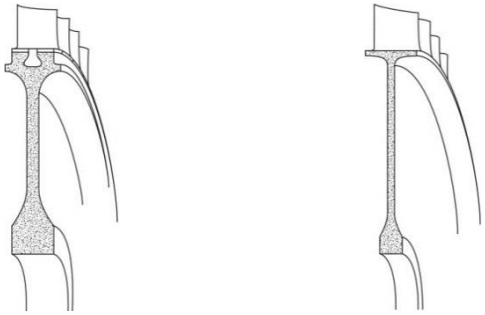
A Blisk is the integrated part of rotating blades and a disk, which is recently being adopted for fan and compressor modules for jet engines. The blisk is expected to contribute the weight reduction and the performance improvement by reducing the leak air between blade platforms. The blisk is generally manufactured by milling from the large forged material, but large amount of material is wasted as cutting tips. Linear friction welding is expected method to save the wasted material.



Blade and disk structure　　Blisk

Fig.1 Comparison between Bladed Disk and Blisk
(R. Turner et al. / Acta Materialia 59 (2011) 3792–3803)

Linear friction welding is a kind of the solid state joining, and the welding method in which the welding defects are not easily formed and the static strength reduction does not occur. However since the effect of residual stress exists, it should be carefully evaluated the fatigue strength of the linear friction welded joints. The purpose of this research is to investigate the effect of the fatigue strength of Ti-6Al-4V LFW joint by comparing those of the as weld joints and the joints which are post weld heat treated(PWHT).

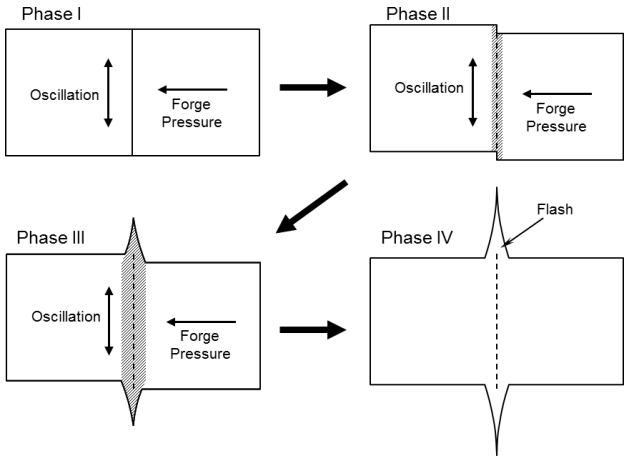


Fig. 2 Schematic view of process of linear friction welding (LFW)

The fatigue test piece of linear friction welding joints and the parent material are made from the same forged material to minimize the effect of scatter of material strength. Ti-6Al-4V is used which is widely used for fan and compressor disks and blades of aircraft jet engines. The forged material used in this research is actually used for jet engine components manufacturing.

Fatigue tests are conducted and the S-N diagrams are compared among those of parent material, as weld joint and PWHT LFW joint. Fatigue strength of as weld joint is slightly lower than that of parent material. Covariance analysis is conducted between parent material and PWHT LFW joint, and it is made clear that the fatigue strength of PWHT LFW joint is the same as that of parent material.

Since it is thought that the fatigue strength reduction of as weld joint is due to residual stress, the residual stress of as weld joint and PWHT LFW joint are measured by Center Hole Drilling method. It is confirmed that the residual stress of PWHT LFW joint is reduced.

As a conclusion, it is confirmed that the fatigue strength of PWHT LFW joint is not reduced in comparison with that of parent material with the statistical data.