Strain-controlled fatigue testing of additive layer manufactured titanium alloy Ti-6Al-4V

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Additive-layer manufacturing (ALM) methods are developing rapidly in many industries to reduce weight and lead times; with an additional advantage in aerospace for significant reduction in material buy-to-fly ratio. Aerospace OEMs and suppliers are identifying appropriate applications for ALM components and progressing their use from development prototypes, into components qualified for service on production aircraft.

This paper describes strain-controlled fatigue testing of a titanium Ti-6Al-4V alloy, additive layer manufactured by two powder bed fusion methods; electron beam melting (EBM) and selective laser melting (SLM).

The EBM additively manufactured material includes comparison of results from material with no post-manufacture heat treatment ("as-built") and after a hot isostatic pressing (HIP) treatment. This HIP treatment condition is further examined to assess directional fatigue properties, using specimens manufactured with build directions vertical, horizontal and at 45 degrees to the axis of the specimen.

These fatigue test results are compared with those for similar titanium Ti-6Al-4V alloy manufactured by traditional wrought mill and by powder metallurgy hot-isostatic pressing.

An example comparison for EBM in the as-built and HIP conditions, both with vertical build direction, compared with wrought mill stock, is shown in Figure 1.

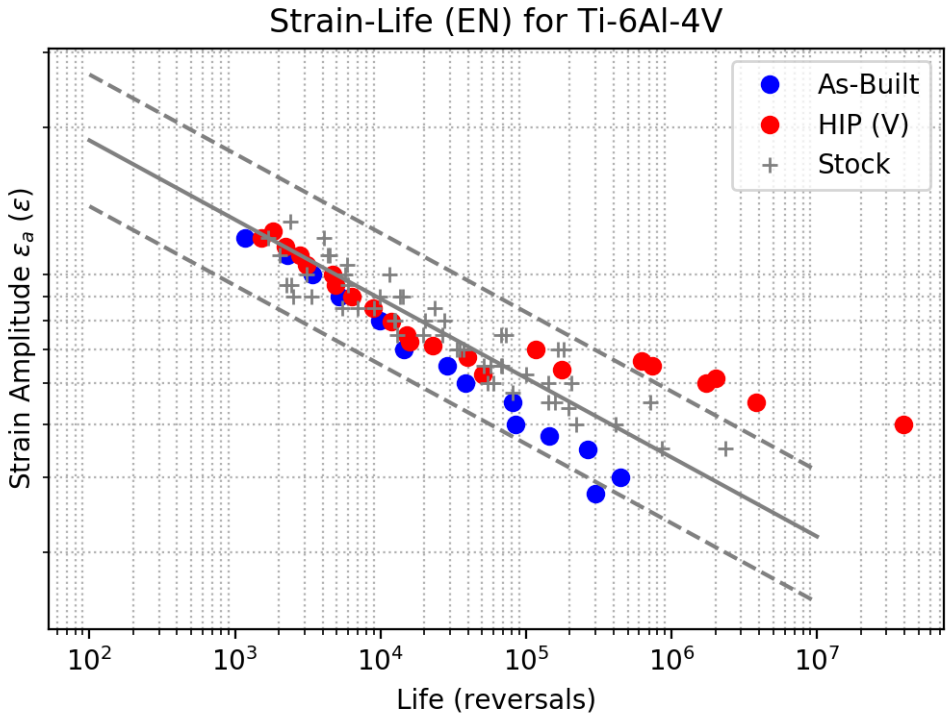

Figure 1. Comparison of fatigue test results for EBM, as-built and HIP conditions, with wrought stock.