

## **Report of the supervisor on the doctoral thesis of Ing. Tomáš Babinský**

The doctoral thesis of Ing. Tomáš Babinský are devoted to the study of the fatigue damage mechanisms in nickel-based RENE 41 superalloy. Nickel-based superalloys are used for the design and production of jet engine components and in service are subjected to variable temperatures and strains. Their resistance to low-cycle fatigue namely initiation and growth of fatigue cracks is decisive for the reliability of the engines. The thesis is thus devoted to the problem of clarifying the mechanism of fatigue damage in important structural material.

To successfully solve the problem the candidate has to master many demanding experimental techniques like preparation of clean surfaces, production of thin foils, observations and documentation in scanning and transmission electron microscopes, and the production of FIB trenches. He managed rapidly experimental methods and also the analysis of the literature on the subject of the thesis. The systematic work on the numerous lamellae produced from the surface of fatigued specimens resulted in an impacted publication on the surface relief evolution and fatigue crack initiation in RENE 41 superalloy. He also participated in several other projects at the institute. His stays abroad (Germany, Serbia) resulted in further publications on the subject of additively manufactured materials including superalloys. He actively participated in several international conferences.

The thesis represents an important contribution to the field of fatigue damage in high-resistant materials for high-temperature applications. The most important results:

- (i) Analysis of the cyclic plastic response of the superalloy using the statistical theory of the hysteresis loop and the relation of the cyclic plasticity with the internal structure both at room temperature and temperature 800 °C.
- (ii) Original observations of the shape of persistent slip markings (extrusions and intrusions) in RENE 41 superalloy (in solutionized and aged states) fatigued at room temperature. Relation of the extrusions and intrusions with the dislocation structure of the persistent slip bands producing these persistent slip markings.
- (iii) Analysis of the effect of the surface relief on the initiation of fatigue cracks.

(iv) Observation and analysis of the high-temperature fatigue damage in RENE 41 superalloy and the explanation of the reduction of the fatigue life in a high-temperature environment.

These relevant results were achieved due to the high effort and also the high level of scientific competence the candidate achieved during his Ph.D. study. He was able to analyze successfully scientific literature, master experimental facilities, and devote enough attention to the presentation of the results.

**The manuscript of the thesis has a high scientific level and contains original results. I can recommend it to be accepted as a Ph.D. thesis.**

Brno, 28th April 2023

Prof. RNDr. Jaroslav Polák, DrSc. dr.h.c.

Ph.D. supervisor