実験報告書様式（一般利用課題・成果公開利用）

（ ※本報告書は英語で記述してください。ただし、産業利用課題として採択されている方は日本語で記述していただいても結構です。）

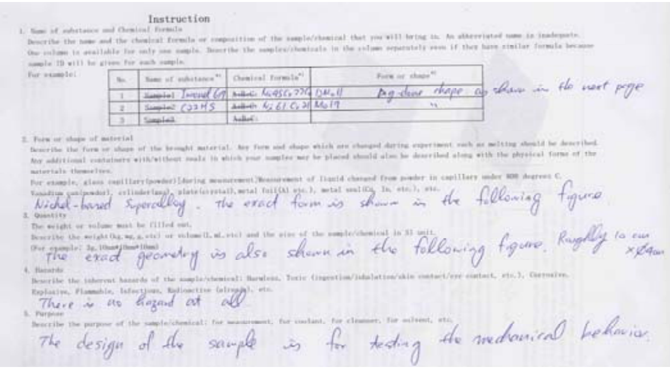
MLF Experimental Report

J-PARC **MLF Experimental Report**	提出日 Date of Report 2013/2/23
課題番号 Project No. 2012A0115 実験課題名 Title of experiment High-temperature Fatigue Behavior Study for High-efficiency Power Plant Systems 実験責任者名 Name of principal investigator E-Wen Huang 所属 Affiliation National Central University	装置責任者 Name of responsible person Dr. Stefanus Harjo 装置名 Name of Instrument/(BL No.) BL-19 実施日 Date of Experiment 2012/10/27~11/1

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）

Please report your samples, experimental method and results, discussion and conclusions.　Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.


Instruction

Nickel-based Superalloy. The exact form is shown in the following figure

The exact geometry is also shown in the following figure. Roughly 10 cm × ϕ4 cm

There is no hazard at all

The design of the sample is for testing the mechanical behavior

Table 1 - Limiting Chemical Composition, %, of INCONEL alloy 617

Nickel	44.5 min.
Chromium	20.0-24.0
Cobalt	10.0-15.0
Molybdenum	8.0-10.0
Aluminum	0.8-1.5
Carbon	0.05-0.15
Iron	3.0 max.
Manganese	1.0 max.
Silicon	1.0 max.
Sulfur	0.015 max.
Titanium	0.6 max.
Copper	0.5 max.
Boron	0.006 max.

2. 実験方法及び結果（実験がうまくいかなかった場合、その理由を記述してください。）

Experimental method and results.　If you failed to conduct experiment as planned, please describe reasons.

Spallation-neutron-source-yielded multiple diffraction combining with the *in-situ* high-temperature experimental environment was applied to study high-temperature fatigue behavior of a specific structural material, which will be applied for the next-generation power plant. The understanding of the cyclic effects at the lattice level for the different environmental temperatures is of importance to elucidate the thermo-mechanical mechanisms. The main purpose of the executed experiment is taking the advantage of the *in-situ* neutron beam to investigate the kinetics of the lattice-strain evolution subjected to different levels of fatigue stages. There were overall 6 in-situ experiments as summarized in the following list:

1. 850 degree C fatigue
2. 850 degree C tension
3. 600 degree C fatigue
4. 600 degree C tension
5. Room-temperature fatigue
6. Room-temperature tension
7.

2. 実験方法及び結果（つづき） Experimental method and results (continued)

During our experiments at the Materials and Life Science Experimental Facility (MLF) of the Japan Proton Accelerator Research Complex (J-PARC), the plasticity dependence of flow-stress mechanisms subjected to different temperature was studied on the Inconel 617, which is an alloy designed for very-high-temperature applications. Subjected to the cyclic loadings, the creep phenomenon was observed at the 850°C condition, which was not the case of the other two lower temperature environments.

Our study focuses on the lattice-strain-evolution kinetics, which is never investigated, with various temperatures as a function of the fatigue cycles. We applied hydraulic systems (Fig. 1) coupled with the high temperature furnace. The results (Fig. 2) in conjunction with the neutron data provide insights into microscopic creep mechanisms.

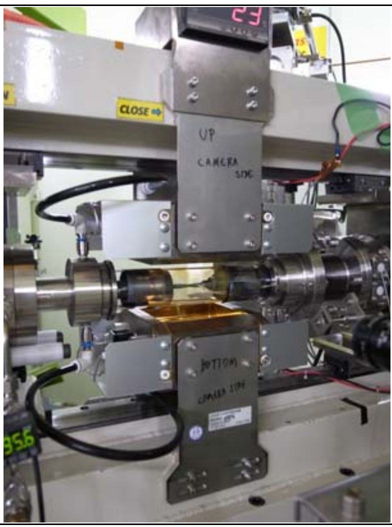


Fig. 1 The specimen mounted in a vacuum furnace on a load frame.

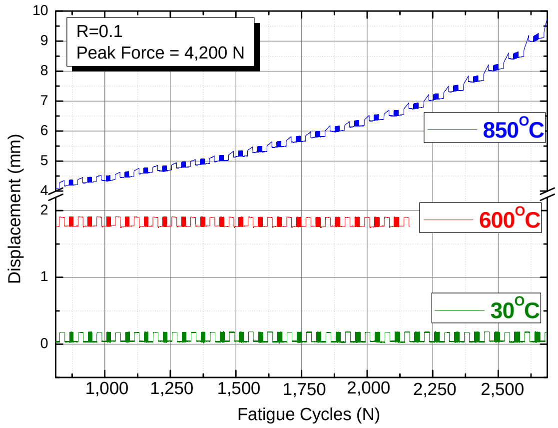


Fig. 2 The displacement evolutions subjected to tension-tension fatigue experiments at 30°C (green lines), 600°C (red lines), and 850°C (blue lines), respectively.

We do appreciate TAKUMI team's dedication. The sophisticated design helps us to easily writing the remote commands on the in-situ machine. Meanwhile, the very fine detector design enables us to extract the orientation-dependent data, which was not possible in other facilities. Specifically, we gratefully acknowledge Dr. Stefanus Harjo and Dr. Wu Gong's help. During our intensive experimental schedule, they carefully taught us TAKUMI's characteristics from setup to the data analysis step by step so that we could fully appreciate TAKUMI's powerful features.

We thank the Users' Office's help very much! Specifically, when we took much longer time to refine and to analyze data than expected, the Users Office and the Users Dormitory officers helped us to solve the need of the additional accommodation in a very efficient manner. Special appreciation is also expressed to Yuko Maejima for her help.