実験報告書様式（一般利用課題・成果公開利用）

MLF Experimental Report

提出日 Date of Report

課題番号 Project No.
2009B0025

実験課題名 Title of experiment
Development of In-situ material evaluation technique using TAKUMI diffractometer

実験責任者名 Name of principal investigator
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装置名 Name of Instrument/（BL No.）
BL19

実施日 Date of Experiment
15/5/2010-18/5/2010

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.

Specimens: S45C dumbbell type specimen

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.

2.1 Development of Load Frame with Furnaces

Furnace system which can be put on the load frame of the TAKUMI diffractometer was developed. Figure 1 shows schematic drawing of load frame with a furnace unit (a) and its photograph (b). The furnace unit consists of an infrared image furnace heating from four directions and a vacuum chamber unit. The maximum temperature was 1000^{o}C and effective heating length is ϕ15xL50mm. Load capacity is 50 kN in tension and 20kN in compression. The vacuum chamber unit can control atmosphere i.e. inert gas, vacuum and air. The CCD camera mounted on the load frame can measure elongation of specimen by measuring the distance between markers such as projections on the specimen as shown in insert photograph in Fig. 1(b). Neutron can pass through interspaces between top and bottom furnaces.

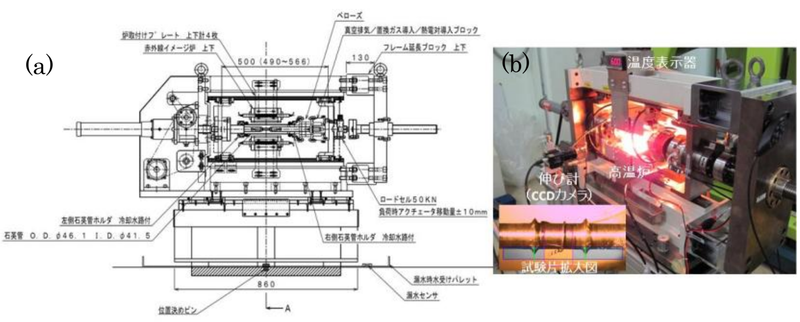

Fig.1 Schematic drawing of the load frame with furnace (a) and its photograph (b).

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

2.2 Offline Test

(1) Tensile test

Dumbbell type specimen with 5mm diameter was set on the load frame with a thermocouple. Tensile test was carried out at room temperature and 1000°C in vacuum and cross-head speed was set at 0.1 mm/min. Figure 2 shows change in macroscopic strains as a function of applied stress. The specimen was yielded at approx. 30 MPa at 1000°C and showed plastic deformation more than 10 %, whereas elastic deformation was observed until 400 MPa at room temperature.

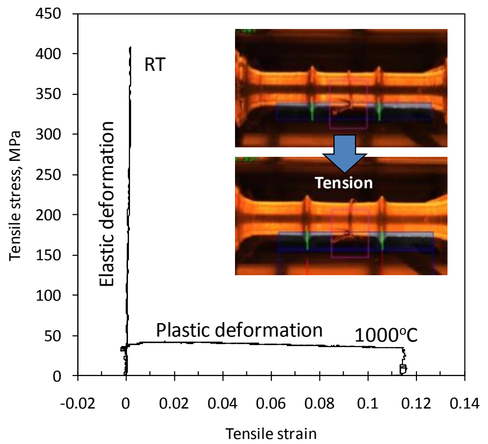

Fig.2 Relationship between tensile applied stress and macroscopic strain at RT and 1000°C.

(2) Compression test

Dumbbell type specimen with 6mm diameter and 9mm length of parallel part was utilized. Compression test was carried out at room temperature and 1000°C in vacuum and cross-head speeds at room temperature and 1000°C were set at 0.1 mm/min and 0.2 mm/min, respectively. As shown in Fig. 3, the specimen was yielded at approx. 25 MPa at 1000°C and showed large plastic deformation more than 40 %, whereas elastic deformation was observed until 400 MPa at room temperature. However, macroscopic shear deformation was observed as shown in insert photographs in Fig. 3 due to misalignment of load axis, which is problem to be solved.

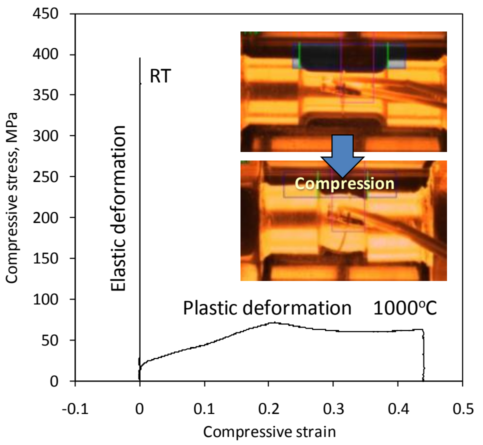

Fig.3 Relationship between compressive applied stress and macroscopic strain at RT and 1000°C.

2.3 On-beam Test

S45C dumbbell type specimen with 6mm diameter and 9mm length of parallel part was set on the load frame with a thermocouple. Diffraction patterns were measured during tensile loading at room temperature and 600°C. Figure 4 shows peak shifts of 110 reflection and change in macroscopic displacement at 600°C as a function of applied stress. Lattice spacing was clearly increased in an elastic region at room temperature, and then became almost constant in a plastic region, and the peak width was gradually broadened probably due to increase in dislocation densities. In contrast, increase in lattice spacing was not clearly observed at 600°C since elastic region was negligible. It is notable that effect of annealing sharpened the peak width even though plastic deformation was increased.

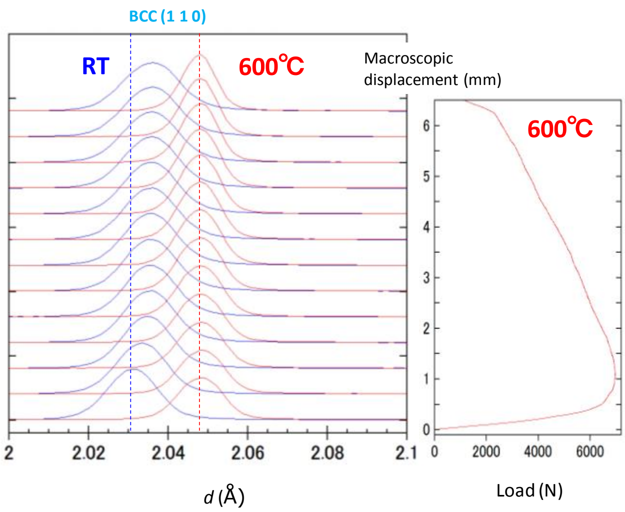

Fig.4 peak shifts of 110 reflection and change in macroscopic displacement at 600°C as a function of applied stress.

2.3 Conclusions

We developed furnace system which can be put on the load frame of the TAKUMI diffractometer, and it was confirmed that change in diffraction pattern can be measured under tensile loading at high temperature. This system will be helpful for materials evaluation under process and in services.