In situ observation of microstructural formation by neutron diffraction

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1. Introduction

The in situ neutron diffraction during heat treatment and/or deformation has become poplar at iMATERIA since the developments of special sample environments. The in situ tensile deformation test required a large test piece as shown in Fig. 1 (a). This shape is based on JIS B 14 type specimen, which has been referred by industrial use. However, for scientific research, it is sometimes difficult to prepare such a large sample. Hence, we developed the new anvil to hold the somewhat smaller specimen shown in Fig. 1 (b). The aim of this study is to evaluate the possibility of the in situ neutron diffraction experiment for this new type of specimen.

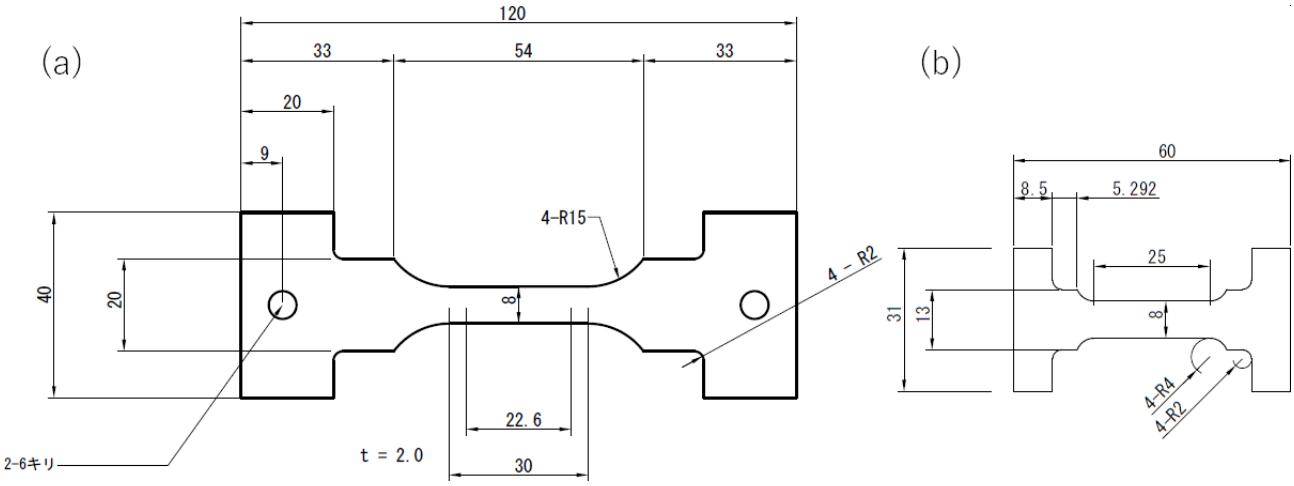

Fig. 1 Tensile coupon design. (a) 14B type, (b) newly developed shape.

2. Experiment

The sample was Fe-5Mn-0.09C medium Mn TRIP steel consisted of martensite and austenite phase. The thickness was 2 mm. The sample was set to the anvils shown in Fig. 2. The anvils and samples could easily be set to the testing machine as in the same manner for cylindrical tensile specimen. The in situ measurement during tensile deformation was conducted at room temperature. The phase fraction and texture were analyzed by using MAUD software.

Fig. 2 The sample attached on the anvils.

3. Results

Figure 3 shows the stress-strain curve and change of austenite fraction during the tensile loading. The diffraction measurement was successfully conducted without any problem. As clearly seen, the yield drop and subsequent plateau region are confirmed at the beginning of plastic deformation. The austenite fraction is dramatically decreased during the plateau. After that, the gradual decrease of austenite corresponds to the strain hardening region. Unfortunately, the anvil was broken at the strain of 0.38 instead of the sample. Later we repeated the test with the gauge thickness of 1 mm (Fig. 4). This was deformed up to the fracture. With the current design, the maximum load available was estimated as around 15 kN. It is clear that we should design the sample shape by considering the limit of anvil strength.

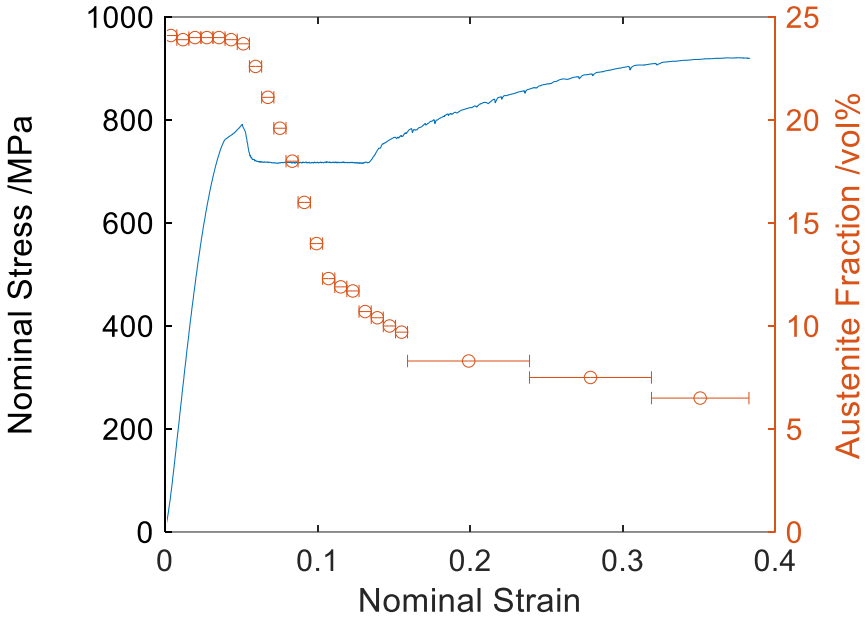

Fig. 3 Stress-strain curve and change of austenite phase fraction.

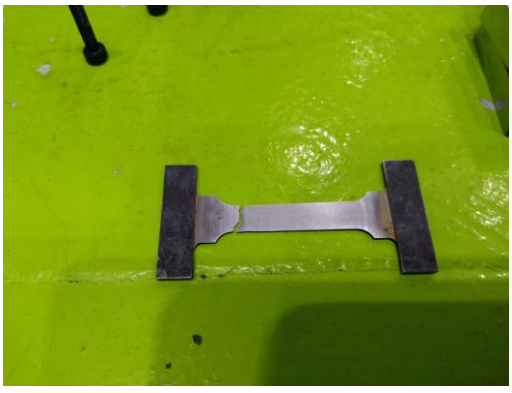

Fig. 4 the fractured sample.

4. Conclusion

The new anvil for the small tensile specimen was tested. Unfortunately, the anvil was broken at 15 kN due to the stress concentration at hooking parts. Even though careful design of the experiment is needed, the diffraction measurement can be conducted without shutting out any diffraction paths for the detectors.