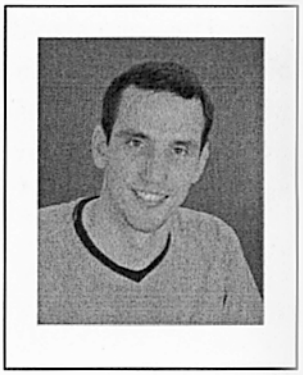
INVESTIGATION OF MICRO-CRACK PROPAGATION IN THE NICKEL BASED ALLOY 80A DURING HOT FORMING BY 3D-EBSD



Stefan Mitsche[1,*], K. Jantscher[1], C. Sommitsch[2] and P. Pölt[1]
[1] Graz University of Technology, Institute for Electron Microscopy
Steyrergasse 17, AT-8010 Graz, Austria
[2] Graz University of Technology, Institute for Materials Science and Welding
Kopernikusgasse 24/I, AT-8010 Graz, Austria
* stefan.mitsche@felmi-zfe.at

ABSTRACT

The presence of very narrow deformation windows in terms of temperature and strain rate are well known for many deformable materials. If these windows are not complied with, there is a strong probability for the initiation of cracks. Investigating these cracks in a two-dimensional cross-section, a determination of the direction of the crack propagation would be difficult, since the actual start and end point of the crack are normally not present. A 3D investigation will give us the probability to determine both the crack propagation and the structures surrounding the crack more easily.

A nickel based alloy 80A, which was hot compressed with a hydraulic press at a temperature of 1000 °C at a strain rate of 0.39 $1.s^{-1}$ to a strain of 0.59, was investigated by 3D-EBSD. The actual measurements were carried out on a half of the transversal cross-sections at half the specimen height. To enable sectioning of large areas, polishing was used. After each polishing step different areas containing cracks were mapped by EBSD, using a system from EDAX-TSL, attached to a Zeiss Ultra 55. The analysis of the EBSD maps was performed with the TSL OIM analysis software V6.1.3.

The specimen was partially re-crystallized with a gradient of the re-crystallized fraction from the edge to the centre of the specimen (~40 % at 2/3 of the radius, ~25 % at the edge). It could be shown that cracks also propagate through re-crystallized grains. The interesting point is that these re-crystallized grains are not completely fractured, which indicates that they might have a stopping effect on the crack propagation. This stopping effect is confirmed by the fact that the tips of the cracks are always surrounded by re-crystallized grains. The body of the cracks is often enclosed by deformed grains. Close to the cracks these grains always show a high orientation spread which is generally caused by high strains linked to a high dislocation density in the crystal lattice of the respective grain. From this behaviour it can be concluded that in the case of the nickel based alloy 80A the formation of cracks does not lead to a relaxation in its surrounding.