Elastic strain analysis of a three-point bending for steel sheet using by EBSD-Wilkinson method.

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Elastic strain in individual crystal grains of steel products plays important roles on their properties such as strength of high-tensile strength steel sheet and iron loss of electromagnetic steel sheet. Understanding microscopic elastic strain distribution is thus crucial in order to design new steel products with superior performances. However, the techniques evaluating the local elastic strain of polycrystalline materials are still under development.

We have applied electron backscattering diffraction (EBSD) - Wilkinson method to measure the local elastic strain introduced by a three-point bending for steel sheet. EBSD patterns were obtained for the identical area of the cross section of the steel sheet before and after the bending using a field-emission scanning electron microscope (SEM) equipped with a hand-made bending holder. The elastic strain in individual grains was successfully evaluated using EBSD patterns measured before the deformation as reference patterns for each grain. The elastic strains in the grains were not uniform and showed complex distributions which could not be simply explained by a macroscopic three-point bending picture of sheet material. The results clearly demonstrate that effects of crystal orientation of each grain and/or the restraint of them by surrounding crystal grains are important on the deformation of polycrystalline steel materials. We also showed that the EBSD-Wilkinson method evaluates plastic deformation in each grain by extracting distributions of local rotations. Our approach has a potential to clarify the whole strain picture for polycrystalline material.