Optimization of sigma phase characterizations in superduplex stainless steel

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Superduplex stainless steel (SDSS) with its attractive mechanical and anti-corrosion properties has been widely used in offshore industry, and the ideal SDSS is well known to coexist with equal amount of austenite (gamma) and ferrite (alpha) phases. However, small amounts of undesirable sigma phase may be promoted during heat treatment, which potentially may cause brittle failure of the material. In previous work [1], the sigma phase identification and characterization were carried out through optimization of the Hough parameters during electron backscatter diffraction (EBSD) indexing. In this project, an optimization method is employed for further improving the EBSD pattern quality. For each sample point, several patterns are collected from the same point, and a final averaged EBSD pattern is obtained by summarizing and dividing by the collected pattern numbers.
An SDSS (UNS S32760) sample was heat treated for 35 mins at 800 °C and quenched to obtain 3.2% sigma phase. Offline EBSD was performed on Zeiss Ultra FEG SEM by using the NORDIF3.0 EBSD. The overview result under the present heat treatment condition reveals that nucleation and growth of the sigma phase corresponds with a small increase in austenite and a decrease in ferrite phases, compared to the original sigma free SDSS sample. The present optimization method in general gave a positive effect for improving the identification accuracy, and the best identification result was obtained by using an averaging with 5 EBSD patterns for each experimental scanned point. Under this optimized averaging condition as shown Figure 1(b), the present results show that the confidence index (CI) of the sigma phase increase up to 0.943 and the averaged image quality (IQ) increased from 1972.04 to 2535.78 compared with the original EBSD pattern without the optimized averaging shown in Figure 1(a) [2].

[1] Elstad K.R., R. Kloe, Y.D. Yu, M. Karlsen, I. Westermann, T. Breivik and J. Hjelen, SCANDEM (2016).

[2] Kleppen K., MSc Project Report, NTNU, Trondheim (2017).

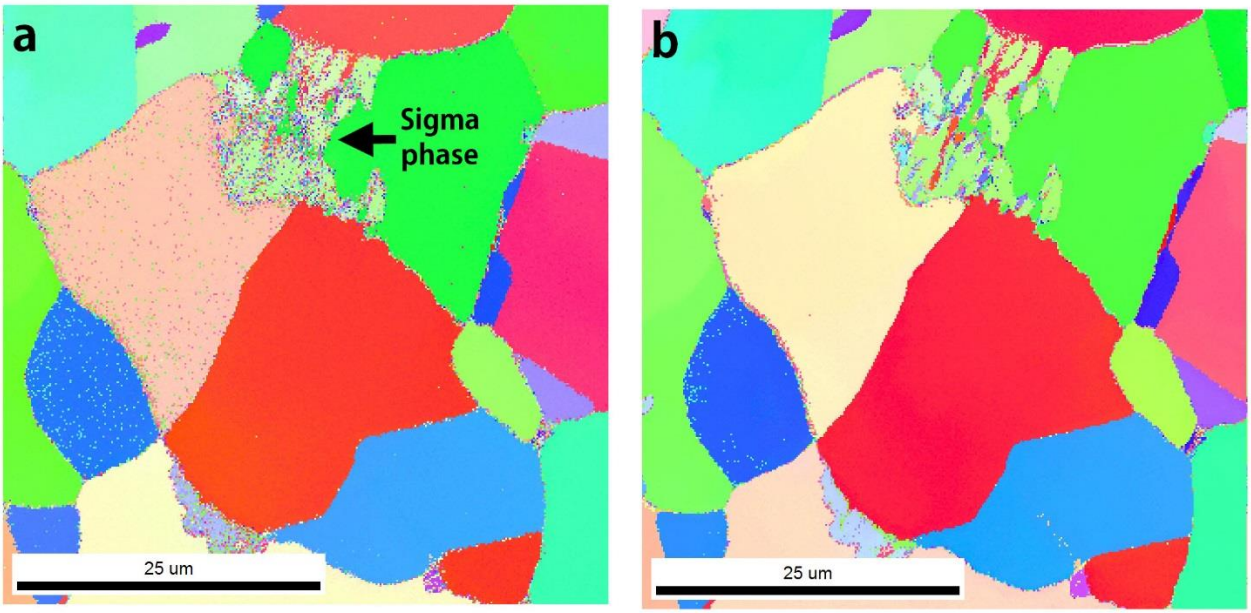

Fig.1 Inverse pole figure maps of the original EBSD pattern without optimized averaging (a) and with 5 pattern averaging (b).