Characterization of forming-induced damage of bent and hot flat rolled DP800 steel sheets by micromagnetic testing

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Keywords: damage, forming, damage characterizeation, barkhausen noise

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During bending and hot flat rolling, the microstructure of a steel is changing and the evolution of damage in the microstructure is possible. Damage describes the decrease of the load-bearing capacity due to the appearance and evolution of voids [1]. During forming, damage develops as a result of the nucleation, growth and coalescence of voids. Damage has a significant impact on the lifetime of a material [1]. The verification of its appearance is very complex and e.g. a metallographic proof and examination with SEM is a time-consuming and destructive testing method.

Micromagnetic material testing is a non-destructive method for material characterization. The aim of this investigation was the qualification of the 3MA-II System (Fraunhofer IZFP, Saarbruecken) for damage characterization. Firstly, the suitability of micromagnetic testing for the identification and quantification of forming-induced damage in the microstructure was verified. Subsequently, the test method was transferred to workpieces of hot flat rolled micro-alloyed mild steel, which has the potential to be transformed into DP800 in further process steps.

DP800 steel with different characteristic damage levels was tested. The damage levels were produced by two different bending methods: Air-bending (Air-B) that is without elastomer and radial stress superposed (RSS) bending, that is with elastomer cushion, which inhibits the evolution of damage [2]. A less damaged sample has a lower triaxility η [2].

The measurements were performed at five positions in the bending zone: positions 1 and 5 are located at the edge of the specimen and positions 2-4 in the middle of the specimen. The results show, that the evaluation of different damage levels is possible by magnetic Barkhausen noise (MBN) measurement. In *Figure 1* the less damaged RSS-samples show a significant higher maximum MBN amplitude M_{max} than the more damaged air-bended samples. Also the average MBN amplitude M_{mean} of the RSS-samples is significantly higher than the M_{mean} of the air-bended samples (*Figure 2*). Consequently, there is a correlation between the damage and the MBN amplitude; a high amount of voids in the microstructure prevents the evolution of a high noise amplitude.

The micro-alloyed mild steel was hot flat rolled to different thicknesses and pass reductions [3]. The influence of the manufacturing parameters on the closure of voids was investigated by MBN. A correlation between the number of voids per 100 mm² and the maximum MBN amplitude M_{max} could be shown.

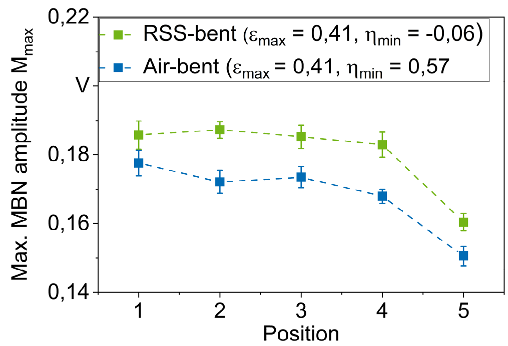

Figure 1. Maximum magnetic Barkhausen noise (MBN) amplitude M_{max} of RSS- and Air-B bended DP800 steel samples

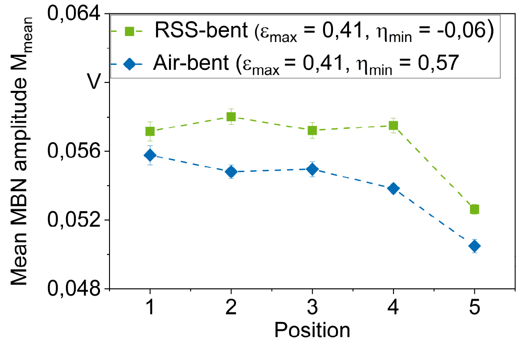

Figure 2. Mean magnetic Barkhausen noise (MBN) amplitude M_{max} of RSS- and Air-B bended DP800 steel samples

Acknowledgments: Funded by the Deutsche Forschungs-gemeinschaft (DFG, German Research Foundation) – project number 278868966 within collaborative research center CRC/Transregio 188 "Damage-Controlled Forming Processes". The results have been created in particular by sub-project B01, many thanks to sub-projects A04 and A05 for the provision of specimens in the framework of an excellent collaboration.

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