Barkhausen noise in soft magnetic composites

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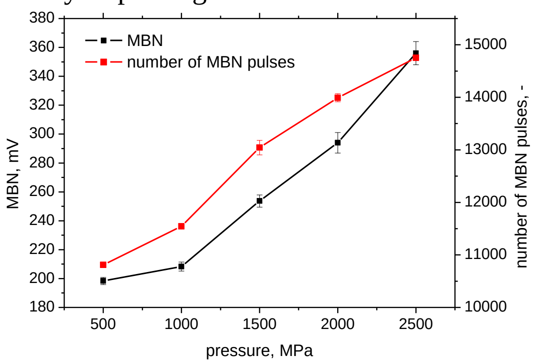
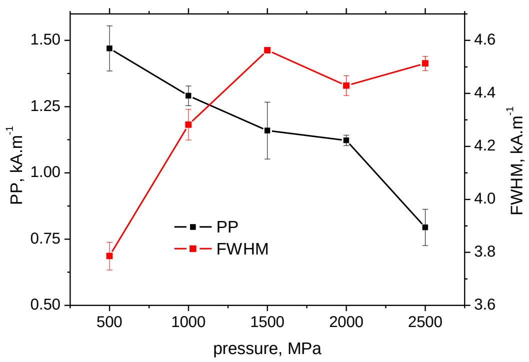
Fig. 1a demonstrates that magnetic Barkhausen noise (MBN) tends grows along with increasing pressure during pressing process in green soft magnetic composites (cold molded Fe powder). Two different aspects contribute to the increasing MBN. The first one can be viewed in the low density of pinning sites as a result of the low initial dislocation density of powder and its high purity. For this reason, mainly grain boundaries can be considered as the main pinning sites. As soon as certain degree of plastic deformation is attained, MBN can grow as results of initiation of dislocation slip and presence of dislocation tangles which hinder DWs in motion and act as pinning sites [1, 2]. Also superimposing contribution of the increasing density of grain boundaries (as the pinning sites) due to the large particles refinement should be taken into consideration.

The second aspect is related to the mutual magnetic exchange communication among the neighboring grains. The distance among the particles becomes lower at the higher pressures. This effects improves mutual communication among the neighboring particles since DWs motion occur in the form of avalanches. Initiation of domains and the corresponding DWs motion triggers similar process in the neighboring particles (or grains). Improved exchange interaction among grains is due lower porosity and increasing fraction of iron-iron bridges in the pressed powder. Fig. 1a also shows increasing number of detected pulses due to grains refinement and increasing density of pinning sites.



(a) evolution of MBN and number of pulses



(b) evolution of *PP* and *FWHM*

Figure 1: Evolution of MBN, number of pulses, *PP* and *FWHM* along with pressure.

Fig. 1b depicts that MBN envelopes are shifted towards lower magnetising fields (decreasing *PP* parameters – *PP* is the position of magnetic field in which MBN attains the maximum) and the matrix becomes softer from the magnetic point of view along with increasing pressure. Being so, it can be reported that with respect of the decreasing *PP* the improved magnetic interaction among the neighbouring Fe particles prevails whereas the contribution of increasing dislocation density is only minor. Fig. 1b also depicts that *FWHM* rapidly grows with pressure followed by saturation phase for the above 1500 MPa. This parameter expresses the degree of heterogeneity of conditions in which DWs is initiated. The most remarkable alterations with respect average misorientation as well as the fraction of iron-iron bridges are developed in the range of pressures from 500 to 1500 MPa. The differences among the powders pressed at the higher pressures are much lower. The higher *FWHM* for the high pressure originates from the different pinning strength of pinning sites in the regions containing dislocation tangles as compared with those located in the particles (or grain) interior.

References

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[2] M. Neslušan, et. al.: Measurement of the rate of transformation induced plasticity in TRIP steel by the use of Barkhausen noise emission as a function of plastic straining, ISA Trans. 125, 318-329 (2022).