

Improvement of Magnetic Properties in Iron-Silicon Electrical Steel for Highly Efficient AC Motors



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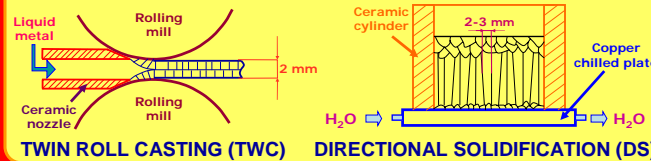
OBJECTIVE

SCIENTIFIC – understanding the physics behind the loss and recovery of the sheet texture with <001> direction normal to the sheet during deformation and recrystallization in BCC polycrystalline materials.

ENGINEERING – development of a processing route that retains the maximum amount of the desired initial <001> texture and significantly improves the efficiency of electric motors.

PROCESSING CHALLENGE

To produce electrical steel with the best magnetic properties, i.e. with preferred <001> sheet texture, with grain size $\sim 150\mu\text{m}$ and sheet thickness $\sim 0.5\text{mm}$. The desired <001> texture can not only be produced by Twin Roll Casting and Directional Solidification, but they do not meet the desired grain size and sheet thickness.



To achieve all these goals, additional deformation and heat treatments are required, resulting in a reduction of the initial <001> texture.

RESULTS

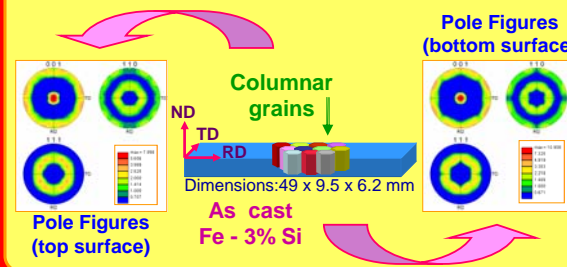
- ❖ Much of the <001> texture was destroyed after heavy rolling.
- ❖ After the first recrystallization, the preferred <001> texture was weakly restored.
- ❖ The additional light rolling rotated the crystals toward the <001> texture.
- ❖ The final recrystallization step resulted in a partial recovery of the <001> sheet texture.

MOTIVATION



- ❖ 60% of all electricity produced is consumed by motors.
- ❖ 20% of energy loss is due to core losses in electrical steel.
- ❖ There is a high need for highly efficient motors.

APPROACH



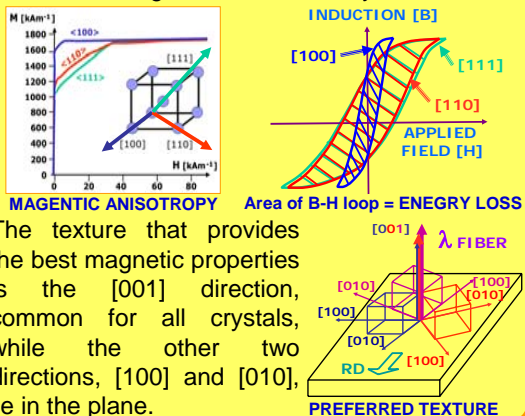
Samples of an iron-silicon alloy were cut from a continuously cast block in such way that the columnar grains have the <001> direction parallel to the normal direction (ND). These samples have the perfect sheet texture and best magnetic properties ever produced.

CONCLUSION

With further optimization of the processing route, it may be possible to maximize the presence of the preferred <001> sheet texture after the final processing step and obtain the desired grain size and optimum sheet thickness. This will dramatically improve magnetic properties of electrical steel, increase the efficiency of electric motors and reduced energy consumption by 30%.

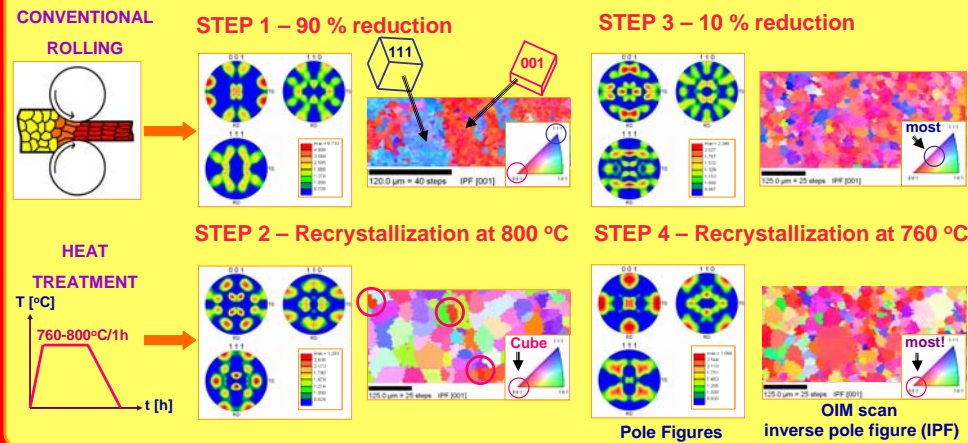
BACKGROUND

Minimization of magnetic losses in electrical steel improves motor efficiency. Magnetic properties (core losses) vary depending on the direction of magnetization in the crystal lattice.



PROCESSING DESIGN

Samples were subjected to a heavy and light cold rolling with subsequent recrystallization to achieve the desired sheet thickness and grain size and to retain the <001> texture.



FINAL THOUGHTS

Improvement of magnetic properties of electrical steel will have a significant impact on motors that run air conditioning units and refrigerators. The wasted energy (converted into heat) has compounding negative effects, which adversely impact our environment, increasing global warming!



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