Comparison of non-oriented material and grain oriented material for an axial flux permanent-magnet machine

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The performance of an axial flux permanent-magnet synchronous machine (AFPMSM) using non-oriented (NO) steel is compared with the performance of an AFPMSM using grain oriented (GO) material. The machine consists of a stator with 15 teeth, placed between two steel rotor discs with 16 permanent magnets each (fig. 1a). Each stator tooth is made as a stack of laser-cut I-shaped laminations (fig. 1b) that are stacked with an overlap zone (fig. 1c).

The machine is modelled by several 2D Finite Element Models in circumferential direction, at different radii. The material model for the grain oriented material is an anisotropic model based on the magnetic energy that returns a magnetization vector **M** as a function of an induction vector **B**. It is a variant to a model [1] that uses the field **H** as input and is based on coenergy instead of energy. Firstly, the magnetic energy is obtained by measuring *BH*-loops on an Epstein frame in 7 directions starting from the rolling direction to the transverse direction. Secondly, **H** is calculated by taking the gradient of the energy to **B**. In comparison with non-oriented material, it was observed that both the saturation induction and the torque are higher with GO material. The field pattern is also different: Fig. 1d shows that in the GO material, *H* is much lower than for NO material in the regions where the field is in the rolling direction (*x*-axis) and higher in the tooth tips where the field has an angle of about 45°.

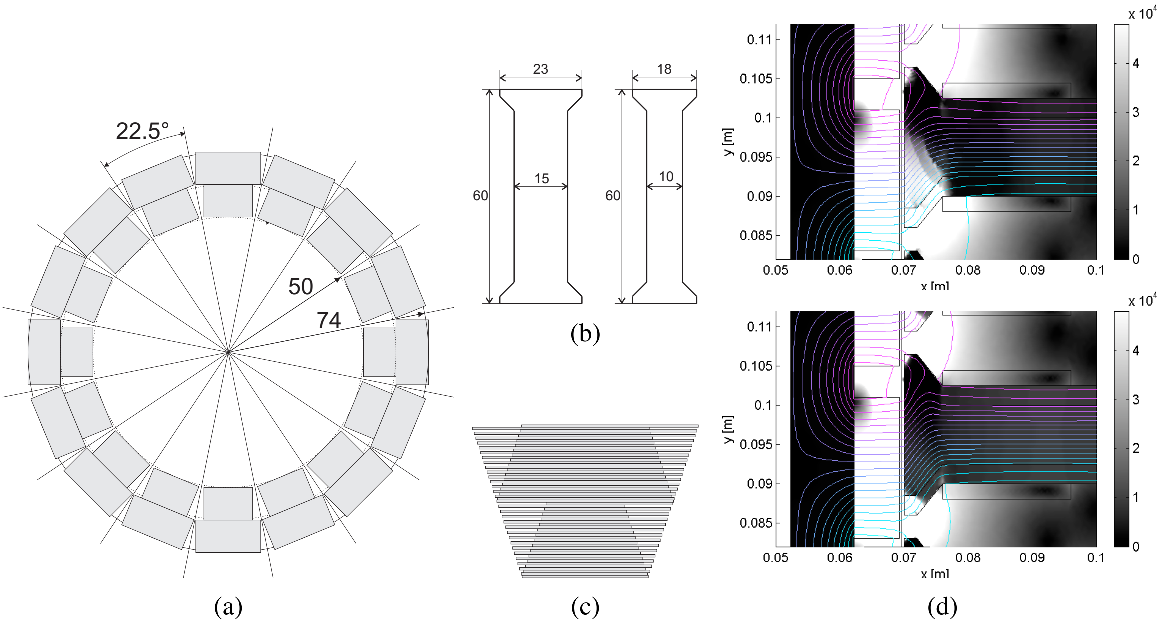

Figure 1: (a) Rotor geometry of the AFPMSM; dimensions in mm (b) Stator laminations [mm]; (c) Cross-section of stacked laminations in stator tooth (d) Field pattern [A/m] in rotor yoke (left), magnets and stator for GO material (top figure) and NO material (bottom figure).

[1] L. Dupré, R. Van Keer, and J. A. Melkebeek, IEEE Trans. Magn., **38** (2002), 813-816.

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