Torque and Flux Density Optimization of a Small BLDC Motor Using the Electromagnetic FEM

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The BLDC (Brushless Direct Current) motor is widely used in various mechanical devices because it has a lot of advantages such as a long life, less noise, a high speed and a higher torque, and a small size. Especially, due to its higher torque-to-volume ratio it is intensively used for the driving motors of small dental and surgical hand-pieces. A rotor consists of a rotating shaft and a permanent hollow magnet and a stator is composed of coils, slots, and a cover. The electromagnetic design optimization for the coil area has been performed using the MAXWELL program and an in-house optimization code in an effort to improve the torque output of a hand-piece BLDC motor. The torques calculated from the existing motor (diameter: 20 mm, length: 28.5 mm) were 28.34 N·mm maximum and 24.20 N·mm minimum, and the measured torque was 25.046 N·mm. For further improvement of the motor torque, electromagnetic optimization has been performed regarding to the number of wound coils and the area of slots. The torque output was improved by 20.45% with the new optimum design.

Keywords: Motor torque, Flux density, Electromagnetic analysis, Optimum design, FEM