Research and Development of Next Generation Motors and Its Future Issues

Satoshi Ogasawara and Masatsugu Takemoto
(Hokkaido University, Sapporo 060-0814, Japan)

This paper introduces research and development of next generation motors for electric vehicles (EVs) and hybrid electric vehicles (HEVs) in Hokkaido University, including a traction motor for HEV and an in-wheel axial-gap motor for electric city commuters. Some design points of the motors and its future issues are described, associated with characteristics of magnetic materials.

Fig. 1 shows proposed structure of a traction motor for hybrid electric vehicles without rare earth materials. Using ferrite magnets, axial gap structure and segment rotor structure are adopted to obtain high performance comparable to the traction motor with rare earth magnets for HEVs. The stator core having 24 tooth is made of SMC core and a 3-phase 10-pole concentrated winding is wound around the stator core. In order to generate reluctance torque, the rotor is structured by building the ferrite PMs and the SMC cores into the rotor support component. In spite of the rare-earth-free motor using the ferrite PM that the energy product is about 1/10 of the rare earth PM, the maximum torque reaches 75.3% of the high-performance PMSM using the rare earth PM in the same volume. The ratio of the reluctance torque is very big of 49.2%, when the maximum torque is generated. The prototype can fulfill an equal output power of 50 kW at the same volume as the high-performance radial gap type PMSM of the second-generation Toyota Prius.

Fig.2 shows proposed structure of a ferrite PM in-wheel motors with axial-gap structure for electric city commuters. The motor is characterized by the sophisticated structure incorporating a reduction gearbox into the inner side of the stator to generate large output torque. In the other side of the stator, a resolver as a position sensor is installed for closed control of the motor. The ferrite PM is used instead of rare earth PM and the coreless structure is adopted to minimize demagnetization of the permanent magnets and to eliminate the rotor iron loss. Three prototypes are constructed and evaluated. Some experimental results will be shown in the presentation.

Reference

1) T. Miura, S. Chino, M. Takemoto, S. Ogasawara, A. Chiba, N. Hoshi: ``A ferrite permanent magnet axial gap motor with segmented rotor structure for the next generation hybrid vehicle'', International Conference Electrical Machines (ICEM), 2010.
2) Masatsugu Takemoto: `` Developments of Ferrite PM In-Wheel Motors with Axial-Gap Structure for Electric City Commuters'', EVTeC & APE Japan 2014, Pacifico Yokohama, Yokohama, JAPAN, May 22-24, 2014.

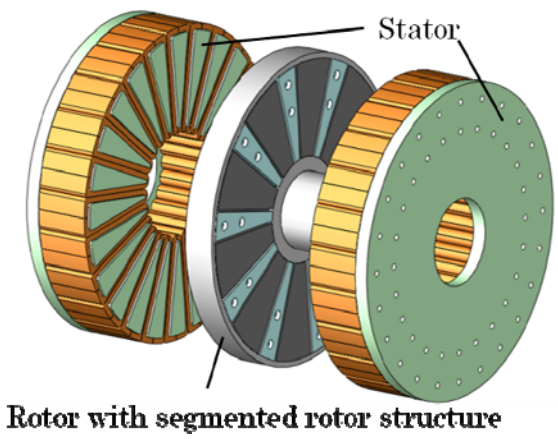

Fig.1 Traction motor for HEVs without rare earth materials.

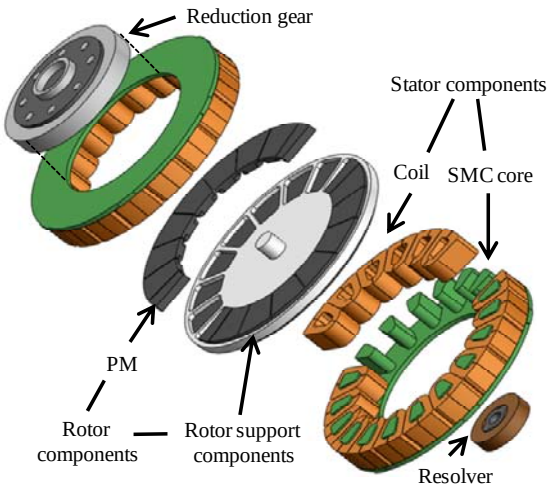

Fig.2 In-wheel axial-gap motor for city commuters.