Abstract

Permanent magnet (PM) machines exhibit high torque density and high efficiency, and are widely used for electric and hybrid electric vehicles. Hybrid-excited permanent magnet machines (HEPMMs) consist of two excitation sources, i.e. PMs and field windings. Both the field excitation current and the d-axis current can be utilized to adjust the flux-linkage. Thus, compared with the conventional PM machines, an extra flexibility to adjust the flux-linkage is provided by the field excitation current. Consequently, higher torque at low speed and wider operating speed range, as well as higher efficiency over wider operation region may be obtained by employing appropriate control strategies. The uncontrolled generator fault during flux-weakening control at high speed in a PM machine is one of the most serious scenarios that can damage the machine and inverter switches. HEPMMs may overcome the resulted overvoltage issue. This plenary presentation will systematically overview the relative merits and demerits of various HEPMMs for electric and hybrid electric vehicle applications. There are numerous HEPMM topologies including (1) both PM and DC coils in rotor; (2) PM in stator and DC coils in rotor, (3) PM in rotor and DC coils in stator; or (4) both PM and DC coils in stator based on doubly salient, flux reversal, switched flux, stator slot PM machines; as well as (5) others based on Vernier machines, hybrid steppers, claw-pole machines, and separate wound field and PM machines etc. The control strategies for HEPMMs based on the utilization of flux weakening currents will also be highlighted by utilising (1) field excitation current only, (2) armature current only, (3) optimal field and armature current hybrid method. Finally, the potential of using HEPMMs to mitigate the overvoltage due to uncontrolled generator fault will be described.