超磁致伸缩执行器全耦合非线性动态有限元模型

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关键词： 超磁致伸缩执行器 涡流 磁滞损失 动态有限元模型 耦合

摘 要： 超磁致伸缩执行器在高频率下工作时，能量损失不仅包括磁滞损失、Terfenol-D棒涡流损失，还包括执行器导磁回路的附加涡流损失，同时执行器上存在磁场、电场、温度场及机械应力场四场之间的耦合。本文考虑超磁致伸缩执行器Terfenol-D棒质量、预压应力、偏置磁场、磁滞和涡流损失，从电场、磁场和机械应力场三场耦合角度，建立超磁致伸缩执行器三维非线性动态有限元模型。超磁致伸缩材料磁滞特性由Berqvist和Engdahl磁滞模型来描述。应用FEMLAB建模分析并与实验结果对比，发现模型与实验结果吻合较好，验证了所建立三维动态FEM模型的正确性。 The giant magnetostrictive actuator works at high frequency, and then the loss of giant magnetostrictive actuator includes magnetic hysteresis loss, eddy currency loss, and excess eddy current loss of actuator loop. The coupling between four fields (i.e., magnetic field, electric field, thermal field and mechanical stress field) is occurred at the actuator. Considering the mass of Terfenol-D rod, pre-stress, biased field, the loss of magnetic hysteresis and eddy current, a 3-D nonlinear dynamic model of GMA was established based on the coupled relationship of the three fields (magnetic field, electric field and mechanical stress field). The magnetic behavior was described by the Berqvist and Engdahl stress dependent magnetic hysteresis model for ferromagnetic hysteresis. The simulation results with commercial software FEMLAB were in agreement well with the experimental data. Therefore, the model constructed is valid, and it can help to optimize design of the GMA.

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