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双锥面齿自支撑轴系行波超声电机设计与有限元分析

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摘要 针对传统的行波超声电机定转子接触面小、输出力矩小，需要轴承定位，存在润滑问题，设计了一种新型双锥面齿驱动的自支撑轴系行波超声电机。首先设计了双锥面齿超声电机的结构，并分析其运行机理，然后利用有限元软件对电机的定子进行模态分析、谐振分析和瞬态分析，不但精确地预测了电机的激励频率，得到定子的振动模态图，而且从理论上获得其振幅和阻抗随频率的变化规律，以及定子齿端上某点随时间变化的位移曲线及其椭圆运动轨迹。最后利用自行研制的电机样机进行了实验，该样机的最大堵转力矩是0.48 N·m，是与其相近尺寸的传统单面齿超声电机的1.7倍，样机的最大空载速度是86 r/min。

关键词 电器工程 双面齿 锥形齿 超声电机 自支撑轴系 谐响应分析

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Finite element analysis and experiment on travelling-wave ultrasonic motor with two-sided cone-shaped teeth and self-supported shafting

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Abstract The conventional one sided travelling-wave ultrasonic motor(TWUSM) needs bearing to support and oil to lubricate, does provide sufficiently high torque and power due to limited contact area between the stator and the rotor, consequently its application is limited. So, a TWUST with the two-sided cone shaped teeth and self-supported shafting was developed. Its structure was designed and its excitation mechanism was analyzed. The model, harmonic, and transient analyses of the motor stator were performed using the FEA software ANSYS. The excitation frequency was predicted precisely, the shapes of the vibration modes, the vibration amplitude and impedance versus frequency behaviors and displacement versus time curve of the tooth tip on the stator and its elliptical locus were obtained theoretically. The developed motor prototype was tested and its load characteristics were measured. The maximum stall torque of 0.48 N·m is reached which is 1.7 times as high as the conventional one sided TWUSM, and its idle speed is 86 r/min.

Key words electrical engineering two-sided gear cone-shaped gear ultrasonic motor self supported shafting harmonic analysis

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