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研究论文

离子聚合物金属复合材料的力电耦合模型

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摘要:

提出了一种基于不可逆热力学和纯弯曲理论的力电耦合模型, 以描述和预测离子聚合物金属复合材料的力电特性. 力电耦合模型的表达形式可简化为含有两个驱动力(电场*E*和压力梯度∇p)的线性等式, 主要依据离子传输、电场作用和弹性变形之间的耦合关系预测IPMC的力电特性; 采用纯弯曲理论近似描述了IPMC的受力特征. 这个力电耦合模型可解释IPMC材料的驱动特性和传感特性, 能较好地预测IPMC在直流激励下的响应, 误差在-7%以内.

关键词: 复合材料 离子聚合物金属复合材料 力电耦合 建模 热力学 纯弯曲

Electromechanical modeling for ionic polymer metal composite based on thermodynamics and pure bending theories

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Abstract:

As a novel kind of sensor and actuator materials, Ionic Polymer Metal Composite (IPMC) has been used in more and more engineering applications fields. And it is urgent to properly model IPMC considering electromechanical relationship to describe its properties. In this paper, an electromechanical model based on nonreversible thermodynamics and pure bending theories was proposed to describe and predict the electrical/mechanical performance of IPMC. The compact description was exhibited by the linear regime with two driving forces (electric field E and pressure gradient ∇p). The model was developed to account for the coupling of ion transport, electric field and elastic deformation to predict the response of the IPMC. The pure bending theory was used to approximately describe the stress characteristic of IPMC. The electromechanical model can explain the actuation and sensing effect of IPMC. The experiment results showed that the model can predict the IPMC responses under DC excitation with the error are within.

Keywords: composites IPMC electromechanical modeling thermodynamic pure bending

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