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理论分析毫米波螺旋线行波管慢波系统导体和介质损耗

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Theoretical Analysis of Conductivity and Dielectric Attenuation in Millimeter-wave TWT Helical SWS

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摘要 该文基于夹持杆分层螺旋带模型和3维电磁场模型分析，详细研究了毫米波螺旋线行波管慢波系统的导体和介质损耗。螺旋带模型中介质损耗考虑为纵向传播常数的虚部，给出电磁场的解析解，导体损耗由螺旋线和管壳表面的面电流不连续性获得。3维电磁场模型分析通过本征模法，求解单周期结构的品质因数和周期储能，获得有限导电率导体和夹持杆陶瓷损耗角带来的慢波系统高频损耗。结果表明，毫米波段螺旋线的导体损耗和夹持杆的介质损耗远大于管壳导体损耗，介质损耗与陶瓷损耗角呈线性关系，对高频损耗的影响不可忽略。

关键词： 螺旋线行波管 毫米波 导体损耗 介质损耗

Abstract: Conductivity and dielectric attenuation in millimeter-wave TWT helical Slow-Wave Structure (SWS) are analyzed by a stratified dielectric helix tape and a 3D electromagnetic model. In tape model, the imaginary part of complex propagation constant is considered as dielectric attenuation, and the conductivity losses are obtained by discontinuous surface current on metal helix and envelope. For 3D electromagnetic model, the RF losses of SWS are deduced through a quality factor and stored energy in a periodic structure with finite conductivity of helix and envelop and loss tangent of supported rods. An analysis of a Ka helical SWS shows that the conductivity loss of helix and dielectric attenuation of supported rods are greater than conductivity loss of envelope, the dielectric attenuation is linear with ceramic loss tangent and can not be neglected in millimeter wave band.

Keywords: Helical Traveling Wave Tube (TWT) Millimeter wave Conductivity attenuation Dielectric attenuation

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