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氯化镍掺杂的碳纳米管对SF6放电分解产物的气敏响应

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摘要：

检测和分析六氟化硫(SF6)气体放电分解产物对于气体绝缘组合电器(gas insulated switchgear，GIS)设备的安全运行有着重要意义。分析碳纳米管的气敏响应机制及掺杂对其气敏性能的改善，研制了一种氯化镍掺杂的多壁碳纳米管传感器，将NiCl2 × 6H2O和浓酸处理过的碳纳米管悬浊液超声掺杂，然后涂布在以印刷电路板为基底的叉指电极上，干燥后作为气敏膜。测试了传感器对SF6放电分解产物的气敏响应，结果表现出良好的灵敏度和快速响应特性，同时也测试了传感器对SOF2、SO2F2和SO2这3种SF6典型分解产物标气的气敏响应，并分析了它们之间的气敏性差异。分析认为，NiCl2掺杂对碳纳米管气敏性能的提高主要体现在：1）增加了碳纳米管的结构缺陷；2）Ni2+ 和气体分子反应进而诱导了碳纳米管气敏膜的势垒发生变化；3）Ni2+ 颗粒自身成为了局部催化活性中心。

关键词： 碳纳米管 掺杂 六氟化硫 分解产物 气敏响应 局部放电

Gas Sensing Response of NiCl2-Doped Carbon Nanotubes to Decomposition Products of SF6 Gas due to Partial Discharge

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Abstract:

It is significant for secure operation of gas insulated switchgears (GIS) to detect and analyze the decomposition products of SF6 gas due to partial discharge. To analyze the mechanism of gas-sensing response of carbon nanotube (CNT) and the improvement of doping to its gas-sensing performance, a multi-walled carbon nanotubes (MWNT) sensor in which NiCl2 is doped is prepared in this way: firstly the ultrasonic doping of suspension liquid of concentrated acid pretreated carbon nanotubes by adding some NiCl2 × 6H2O crystal to it is performed, then the doped suspension liquid is coated onto interdigitated electrode on the base of printed circuit board, and then the dried doped suspension liquid forms gas sensing film. The gas sensing response of the sensor to decomposition products of SF6 gas due to partial discharge is tested and the results show that the sensor possesses good sensitivity and fast response performance, meanwhile the gas sensing responses of the sensor to standard gases of three typical decomposition products, i.e., SOF2, SO2F2 and SO2, are tested and the differences of gas sensing performances among these decomposition products are analyzed. The improvements of gas sensing performance of NiCl2-doped incarnate in following aspects: the structural defects of carbon nanotubes are increased; the reaction between Ni2+ and gas molecules further induces the variation of potential barrier of CNT gas sensing file; the Ni2+ granules themselves become local catalytic active center.

Keywords: carbon nanotubes doped sulphur hexafluoride decomposition products gas-sensing response partial discharge

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