Design and Fabrication of Non-destructive Testing Probe of Superconducting Quantum Interference Device

邱文華、洪振義

E-mail: 9419921@mail.dyu.edu.tw

ABSTRACT

In the industrial world, various kinds of instruments and technology are utilized in non-destructive testing to find inherent and potential defects in products, in order to make products safer and more reliable. Such tests include, for example, the Visual Test, Liquid Penetrant Test, Ultrasonic Test and the Eddy Current Test, etc. The Superconducting QUantum Interference Device, is currently the most sensitive device for use in examinations of magnetism. SQUID was been used in scanner instruments measuring heart magnetism and brain magnetism. When used in such capacities it shows biological heart magnetism or brain magnetism photographs immediately. Therefore, SQUID is used as a clinical auxiliary diagnostic tool in medical science in examining heart and brain functions. SQUID can also be used in the non-destructive testing for materials, SQUID has also been designed for the measurement of steel bone structures of bridges. The object of this thesis is to design the structure of the probe ’s head for a SQUID. Computer-auxiliary-mapping software, AutoCAD and Solid Works, is used to design cooling and vacuum systems. The research objective is to design a probe which provides the best measurement environment for SQUID using glass fiber material (G-10) based on the conditions of vacuum pressure, transition temperature(Tc) and background of the magnetic field. The layout system is fabricated to achieve the optimal examination environment. Research results show that the strength of the glass fiber utilized comes from being soaked in advance and in method used to twine the fiber under processing. Here, tabular or tube-shape material is utilized. Otherwise, the package form will influence the strength of the material, and result in structural stress defect. This works hopes to show ways of improving the probe head system in a SQUID to accurately measure magnetic signals in non-destructive testing.

Keywords : Non-destructive Testing, Superconducting Quantum Interference Device, Glass Fiber Material, Vacuum Pressure, Transition Temperature

Table of Contents

第一章 前言.....1 第二章 文獻回顧.....3 2.1 高溫超導量子干涉元件量測原理.....3 2.1.1 約瑟芬結(Josephson Junction).....3 2.1.2 直流約瑟芬效應(D.C. Josephson Effect).....4 2.1.3 超導量子干涉元件.....5 2.2 玻璃纖維(G-10)的製造方式.....6 第三章 高溫超導量子干涉元件非破壞性檢驗探頭研製.....11 3.1 最初的探頭系統結構設計.....12 3.1.1 探頭系統結構設計說明.....12 3.1.1.1 內杜而瓶(Insider Dewar).....12 3.1.1.2 外杜而瓶(Outsider Dewar).....14 3.1.1.3 探頭系統(內、外度而瓶接合).....16 3.2 玻璃纖維(G-10)材料特性.....17 3.3 溫度計的設計與功能.....19 3.4 低溫真空AB膠材料特性.....21 3.5 SQUID的介紹.....23 3.6 修改部份.....23 3.6.1 內杜而瓶.....23 3.6.2 外杜而瓶下方蓋子.....26 第四章 結果與討論.....27 4.1 探頭系統修改前.....27 4.2 探頭系統修改後.....28 4.2.1 內度而瓶部份.....28 4.2.2 外度而瓶部份.....30 4.3探頭系統量測數據結果.....31 第五章 結論.....33 參考文獻.....35 附錄.....36

REFERENCES

[1] 金重勳，2002，磁性技術手冊，中華民國磁性技術協會。

[2] 李玉芝、張裕恆，1992，超導物理，儒林出版社。

[3] 呂台華、洪姮娥，1988，超導體簡介，中華民國中山學術文化基金會中山文庫。

[4] 侯國深，1985，非破壞性檢測法，徐氏基金會。

[5] 張志純，1986，纖維混成複合材料之應用，徐氏基金會。

[6] 張志純著，1969，玻璃纖維及超級塑鋼大全，徐氏基金會。
[7] 鄭振宗，2000，“ 直流高溫超導SQUID的特性及其在非破壞性檢測上之應用 ”，臺灣師範大學物理研究所博士論文。