

## 中文摘要

本研究以 SOI 晶片為基礎，透過一般型態之電容式平面加速度計為例，探討加速度計元件之設計考量參數，並透過元件設計模擬、製程開發，研製出平面加速度計。並透過量測系統的建置，量測平面加速度計之基本元件特性。從此基礎進而發展新型態透過 SOI 晶片為基礎，研製以差分電容感測電極之出平面加速度計，其中感測電極以氣密閉合架構提高元件靈敏度，並初步驗證出平面加速度計之可行性。此出平面具有：(1)質量塊包含 SOI 晶片之元件層以及處理層；(2)量測之靈敏度因為氣密閉合的差分電極感測而增加；(3)透過金屬連接 SOI 晶片元件層以及處理層的電性；(4)感測電極間距由 SOI 晶片中的氧化層決定。並透過出平面加速度計之設計概念，進一步設計出單一質量塊三軸加速度計，其中三軸感測方向之電極，皆以氣密閉合差分電容感測電極架構來達成。三軸加速度計除了前述出平面加速度計之特向外，具有：(1)透過多晶矽回填技術連接 SOI 晶片元件層以及處理層的電性；(2)三軸感測方向皆是以氣密閉合之差分電容電極為架構，且透過單一質量塊感測三軸方向之設計。最後，製程設計具有批量製造之能力，並初步驗證三軸加速度計之可行性。

關鍵字：SOI、氣密閉合、差分電容電極、三軸加速度計

## Abstract

In this thesis, the design considerations for capacitive-type accelerometer are investigated. The normal type in-plane accelerometer on an SOI wafer is implemented by way of device design, simulation and process development. The typical measurement results are obtained by testing system. A novel capacitive-type out-of-plane accelerometer is presented. This accelerometer contains special designed gap-closing differential sensing electrodes. The present out-of-plane accelerometer has: (1) proof-mass is increased by combining both device and handle silicon layers of the SOI wafer, (2) the sensitivity is improved by gap-closing differential electrodes design, (3) the electrical interconnection between the device and handle layers of the SOI wafer is available by means of the metal-vias, and (4) the sensing gap thickness is precisely defined by the buried-oxide layer of the SOI wafer. Furthermore, according to design concept of the out-of-plane accelerometer, the 3-axis accelerometer with single proof-mass is presented. This 3-axis accelerometer contains gap-closing differential sensing electrodes in all sensing direction. Except of the merits in out-of-plane accelerometer, the present 3-axis accelerometer also has: (1) the electrical interconnection between the device and handle layers of the SOI wafer is available by means of the poly-Si refilled array instead of the metal-vias, and (2) the gap-closing differential sensing electrodes are designed in all direction with single proof-mass. Finally, the process for 3-axis accelerometer has batch fabrication property, and typical measurement results demonstrate the feasibility of 3-axis accelerometer.

**Key words:** SOI, gap-closing, differential capacitive electrodes and 3-axis accelerometer