Design and manufacture of XYZ-three axis precision positioning system

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ABSTRACT

ABSTRACT Recently, the needs for precise micropositioning aries in many fields of research and technology, such as in cellular biology, and SXM(scanning tunneling microscopy or scanning probe microscopy). The requirement of positioning system with submicron order accuracy increases with the development of precision engineering. In this field, the piezoelectric (PZT) material is remarkable in submicron positioning systems for its merits in electromechanical couple. The features of the PZT material, such as less weigh, small size, fast reponse, high resolution, etc., have made it valuable for application in position engineering. However, there are some disadvantages of the PZT devices. The displacement precession of the PZT devices is limited by the hysteresis phenomenon. In addition, the maximum deformation for a piece of PZT material is quite small for most application. In order to improve these properties, the new compositions of the PZT material and multiplayer PZT ceramics have been development in recent years. The reformed PZT devices with these reformed PZT elements may obtain greater displacement and higher precision. In this work, the characteristics of PZT actuators are investigated for its applicability in the scanning tunneling microscope (STM) system. The results are used to establish a high precession positioning stage for STM system. The positioning stage consists of a coarse stage and a three-axis micropositioner. The coarse stage is driven by an InchwormR motor (New Focus Inc.), which has s minimum resolution of 40 nm. The three-axis micropositioner is based on a PZT tube (PZT-5H). The displacement of the high precession positioning stage was measured by using the Optical lever method and the Michelson interferometer method in order to study the hysteresis characteristics as well as the displacement —voltage relation of the micropositioner.

Keywords : PZT ; hysteresis phenomenon ; Scanning Tunneling Microscope ; coarse stage ; three-axis micropositioner

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