Plasma power effect on the surfaces of a quartz crystal during etching using tetrafluoroethane gas

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Abstrak

The performance of a quartz crystal microbalance (QCM) biosensor can be enhanced by patterning the surface of the SiO2 substrate. In this study, the patterning was realized by a plasma etching process. The etching of the SiO2 was carried out using a tetrafluoroethane (CH2FCF3) plasma. The plasma was generated by applying power from a generator. The generator used in this research was a low frequency 40 kHz plasma generator. The generator was equipped with automatic matching circuits, which ensured the stability of plasma power during the experiments. The specimens were produced with a power ranging from 40 watts to 120 watts for 1 hour. The pressure of the chamber was fixed at 1 Torr. The processing gas for this study was a commercial CH2FCF3 gas. The flow rate of the gas was 20 ml/min. The purpose of this research was to study the effect of plasma power on the etching rate and the anisotropy of the etched SiO¬2 surface. The etching rate and the anisotropy strongly correlate with the quality of patterning. Measurement and observation of the etched SiO2 surface were carried out using an optical microscope and a TMS-1200 (Topography Measurement System). The optical microscope was used to determine the etched area from the unetched one, while the TMS was utilized to obtain the thickness and the surface profile. The results show the highest etching rate, i.e., 17.90 nm/min, was obtained by applying a plasma power of 100 watts. The rate demonstrated a relatively slow etching process due to a complex mixture of fluorine (F) and the CH2FCF2 compound. This slow etching rate is preferable for controlling nano-profiles of the pattern. Furthermore, the applied power also had an effect on the anisotropy of the etched profile, and the results of this research show that the best anisotropic coefficient, i.e., 4.8×10-2, occurred in the process with an optimized 110-watt power. The anisotropy was defined as the ratio of the vertical etching rate and the horizontal etching rate. This ratio is important in determining the quality of the profile of the patterned QCM.