Investigation on membrane tension in semiconductor manufacturing

Yu Ching Lee[1]

[1]Mechanical Engineering, National Taiwan University of Science and Technology, Chinese Taipei

Thin membranes can be divided into high-stretching and low-stretching types. Both the varieties of thin membranes and their applications are increasing due to the emergence of many new materials and the improvement of semiconductor manufacturing technology. In recent decades, thin membranes have been utilized in novel fields, such as micro-electromechanical, optoelectronics, displays, semiconductors or biomedical industries. A new analytical technique for evaluating the membrane tension from a dynamic vertical displacement measurement is presented. Two-dimensional wave equations relating the vibration frequencies to the membrane tension are derived. In this experiment, the technique utilizes membrane vibration from a shaker excitation to determine the vibration frequencies. Then, the chromatic confocal microscopy is proposed to measure the time-domain disturbance and fast Fourier transform method is used to calculate the vibration frequency. In addition, different trial-and-error membrane tension values are substituted into the theoretical model to calculate the different vibration frequencies for matching the experimental values. Further simulations are performed to discuss the frequency shift of different vibration frequencies and membrane sizes. It reveals that the higher frequency modes and smaller sizes are more sensitive for predicting the membrane tension. This work emphasizes the feasibility of a quality estimation of photomask protective membrane during semiconductor wafer production by evaluating changes in the material mechanical characteristics.