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Use Multiphysics Simulations and Resistive Pulse Sensing to Study the Effect of Metal and Non-Metal Nanoparticles in Different Salt Concentration

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Abstract : Wafer fabrication is a critical part of the semiconductor process, when the finest linewidth with the improvement of technology continues to decline and the structure development from 2D towards to 3D. The nanoparticles contained in the slurry or in the ultrapure water which used for cleaning have a large influence on the manufacturing process. Therefore, semiconductor industry is hoping to find a viable method for on-line detection the nanoparticles size and concentration. The resistive pulse sensing technology is one of the methods that may cover this question. As we know that nanoparticles properties of material differ significantly from their properties at larger length scales. So, we want to clear that the metal and non-metal nanoparticles translocation dynamic when we use the resistive pulse sensing technology. In this study we try to use the finite element method that contains three governing equations to do multiphysics coupling simulations. The Navier-Stokes equation describes the laminar motion, the Nernst-Planck equation describes the ion transport, and the Poisson equation describes the potential distribution in the flow channel. To explore that the metal nanoparticles and the non-metal nanoparticles in different concentration electrolytes, through the nanochannel caused by ion current changes. Then the reliability of the simulation results was verified by resistive pulse sensing test. The existing results show that the lower ion concentration, the greater effect of nanoparticles on the ion concentration in the nanochannel. The conductive spikes are correlated with nanoparticles surface charge. Then we can be concluded that in the resistive pulse sensing technique, the ion concentration in the nanochannel and nanoparticle properties are important for the translocation dynamic, and they have the interactions.

Keywords : multiphysics simulations, resistive pulse sensing, nanoparticles, nanochannel
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