IT-004

3D feature profile simulation for nanoscale semiconductor plasma processing

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Nanoscale semiconductor plasma processing has become one of the most challenging issues due to the limits of physicochemical fabrication routes with its inherent complexity. The mission of future and emerging plasma processing for development of next generation semiconductor processing is to achieve the ideal nanostructures without abnormal profiles and damages, such as 3D NAND cell array with ultra-high aspect ratio, cylinder capacitors, shallow trench isolation, and 3D logic devices. In spite of significant contributions of research frontiers, these processes are still unveiled due to their inherent complexity of physicochemical behaviors, and gaps in academic research prevent their predictable simulation. To overcome these issues, a Korean plasma consortium began in 2009 with the principal aim to develop a realistic and ultrafast 3D topography simulator of semiconductor plasma processing coupled with zero-D bulk plasma models. In this work, aspects of this computational tool are introduced. The simulator was composed of a multiple 3D level-set based moving algorithm, zero-D bulk plasma module including pulsed plasma processing, a 3D ballistic transport module, and a surface reaction module. The main rate coefficients in bulk and surface reaction models were extracted by molecular simulations or fitting experimental data from several diagnostic tools in an inductively coupled fluorocarbon plasma system. Furthermore, it is well known that realistic ballistic transport is a simulation bottleneck due to the brute-force computation required. In this work, effective parallel computing using graphics processing units was applied to improve the computational performance drastically, so that computer-aided design of these processes is possible due to drastically reduced computational time. Finally, it is demonstrated that 3D feature profile simulations coupled with bulk plasma models can lead to better understanding of abnormal behaviors, such as necking, bowing, etch stops and twisting during high aspect ratio contact hole etch.

Keywords: Feature profile simulation, Plasma etch, GPU

IT-005

High performance of inverted polymer solar cells

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In the past decades, green energy, such as solar energy, wind power, hydropower, biomass energy, geothermal energy, and so on, has been widely investigated and developed to solve energy shortage. Recently, organic solar cells have attracted much attention, because they have many advantages, including low-cost, flexibility, light weight, and easy fabrication [1-3]. Organic solar cells are as a potential candidate of the next generation solar cells.

In this abstract, to improve the power conversion efficiency and the stability, the inverted polymer solar cells with various structures were developed [4-6]. The novel cell structures included the P3HT:PCBM inverted polymer solar cells with AZO nanorods array, with pentacene-doped active layer, and with extra P3HT interfacial layer and PCBM interfacial layer. These three difference structures could respectively improve the performance of the P3HT:PCBM inverted polymer solar cells. For the inverted polymer solar cells with AZO nanorods array as the electronic transportation layer, by using the nanorod structure, the improvement of carrier collection and carrier extraction capabilities could be expected due to an increase in contact area between the nanorod array and the active layer. For the inverted polymer solar cells with pentacene-doped active layer, the hole-electron mobility in the active layer could be balanced by doping pentacene contents. The active layer with the balanced hole-electron mobility could reduce the carrier recombination in the active layers to enhance the photocurrent of the resulting inverted polymer solar cells. For the inverted polymer solar cells with extra P3HT and PCBM interfacial layers, the extra PCBM and P3HT interfacial layers could respectively improve the electron transport and hole transport. The extra PCBM interfacial layer served another function was that led more P3HT moving to the top side of the absorption layer, which reduced the non-continuous pathways of P3HT. It indicated that the recombination centers could be further reduced in the absorption layer. The extra P3HT interfacial layer could let the hole be more easily transported to the MoO3 hole transport layer. The high performance of the novel P3HT:PCBM inverted polymer solar cells with various structures were obtained.

Keywords: organic solar cells, P3HT, PCBM, P3HT:PCBM