분과초청5

Chemistry of mist deposition of organic polymer PEDOT:PSS on crystalline Si

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Chemical mist deposition (CMD) of poly(3,4-ethylenedioxythiophene):poly(styrene sulfonate) (PEDOT:PSS) was investigated with cavitation frequency *f*, solvent, flow rate of nitrogen, substrate temperature T_s, and substrate dc bias V_s as variables for efficient PEDOT:PSS/crystalline (c-)Si heterojunction solar cells (Fig. 1). The high-speed camera and differential mobility analysis characterizations revealed that average size and flux of PEDOT:PSS mist depend on *f*, solvent, and V_s. The size distribution of mist particles including EG/DI water cosolvent is also shown at three different V_ss of 0, 1.5, and 5 kV for a *f* of 3 MHz (Fig. 2). The size distribution of EG/DI water mist without PEDOT:PSS is also shown at the bottom. A peak maximum shifted from 300-350 to 20-30 nm with a narrow band width of ~150 nm for PEDOT:PSS solution, whose maximum number density increased significantly up to 8000/cc with increasing V_s. On the other hand, for EG/water cosolvent mist alone, the peak maximum was observed at a 72.3 nm with a number density of ~700/cc and a band width of ~160 nm and it decreased markedly with increasing V_s. These findings were not observed for PEDOT:PSS/EG/DI water mist. In addition, the Mie scattering image of PEDOT:PSS mist under white bias light was not observed at V_s above 5 kV, because the average size of mist became smaller. These results imply that most of solvent is solvated in PEDOT:PSS molecule and/or solvent is vaporized. Thus, higher *f* and V_s generate preferentially fine mist particle with a narrower band width. Film deposition occurred when V_s was impressed on positive to a c-Si substrate at a Ts of 30-40°C, whereas no deposition of films occurred on negative, implying that negatively charged mist mainly provide the film deposition. The uniform deposition of PEDOT:PSS films occurred on textured c-Si(100) substrate by adjusting T_s and V_s.. The adhesion of CMD PEDOT:PSS to c-Si enhanced by V_s conspicuously compared to that of spin-coated film. The CMD PEDOT:PSS/c-Si solar cell devices on textured c-Si(100) exhibited a η of 11.0% with the better uniformity of the solar cell parameters. Furthermore, η increased to 12.5% with a J_{sc} of 35.6 mA/cm^2, a V_{oc} of 0.53 V, and a *FF* of 0.67 with an antireflection (AR) coating layer of 20-nm-thick CMD molybdenum oxide MoO_x (n= 2.1) using negatively charged mist of 0.1 wt% 12 Molybdo (VI) phosphoric acid n-Hydrate) $H_3(PMo_{12}O_{40})\cdot nH_2O$ in methanol. CMD. These findings suggest that the CMD with negatively charged mist has a great potential for the uniform deposition of organic and inorganic on textured c-Si substrate by adjusting T_s and V_s.

Keywords: C-Si/PEDOT:PSS, solar cells, Mist deposition, growth kinetics

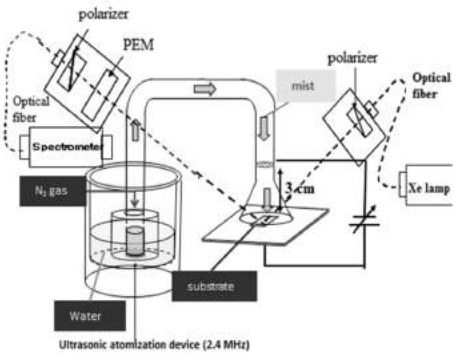

Fig. 1 Schematic of CMD

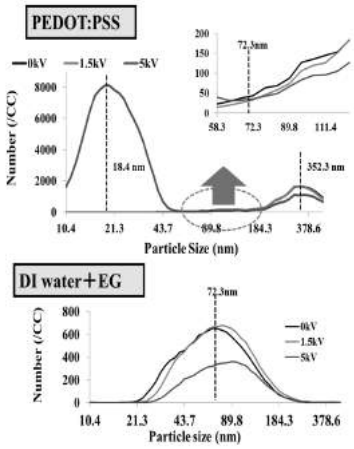

Fig. 2 Size distribution of mist at different V_ss