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Photoluminescence characteristics of Si nano-dots in the SiN_x film fabricated at a low temperature (≤200 ℃)

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We studied formation and dimension control of silicon nano-dots in silicon nitride (SiN_x) films at a low temperature (≤200 ℃) for non-volatile memory devices and photonic devices on flexible substrate. The SiN_x films were fabricated by catalytic chemical vapor deposition (Cat-CVD). SiH_4, NH_3, and H_2 were used as source gases. The substrate temperature and the flow rates of the source gases were varied as control variables. The films fabricated at various substrate temperatures were analyzed by photoluminescence (PL) spectroscopy. Formation of the silicon nano-dot was observed by tunneling electron microscope (TEM). The substrate temperature at least 195 ℃ was necessary to nucleate silicon nano-dots in the films. As the flow rate of H_2 increased, the PL peak intensity at 730 nm increased indicating that the nano-dot density increased. As the NH_3 flow rate increased, the silicon nano-dot size decreased. Therefore, control of the source gas composition was found to be effective in regulating the density and size of the nano-dots.