Super-amphiphobic Nano-wall Structured Teflon Films Deposited by Microwave Plasma

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Super-hydrophobic and oleophobic surfaces have attracted much interest for both fundamental research and practical applications. In this study, Teflon-like fluorocarbon films with nano-wall structure were deposited on various substrates by microwave-generated C4F8/CF4 plasma. The reactor was a long tubular quartz tube with diameter of 5 cm. The substrates were placed in 22 different locations along the flow direction in upstream region, plasma discharge, and afterglow region. It was found that the surface morphology of the deposited film is very location-dependent. As seen in Figure 1, the results are relatively symmetrical to the center of plasma discharge, which reveals the diffusive behavior of the plasma process. The fluorocarbon film is rough with low F/C atomic ratio when substrate is located in the center discharge region (No. 11~15). Fluorocarbon films with nano-wall structure can be deposited on substrates located in the end of upstream region (No. 8) and in the beginning of the afterglow region (No. 18). The F/C ratio of the nano-wall film is 2.0, namely the Teflon structure. It was also found that water contact angle on the Teflon-like nanowall film was above 160° and the CH2I2 contact angle was above 140°. Actinometric OES showed that Teflon-like nanowall film deposited on locations with high CF2 relative intensity. Combining the location dependency and OES result, it is suggested that Teflon-like nanowall film is deposited by soft ion bombardment and abundant CF2 radicals. Finally, by using the same operating parameters, we successfully deposited transparent super-amphiphobic fluorocarbon nanowall film onto various substrates such as glass, copper, polycarbonate, and etc. Moreover, we found that Teflon-like films with nano-wall structure could also be deposited from other fluorocarbon plasmas. We will discuss more details at the conference.

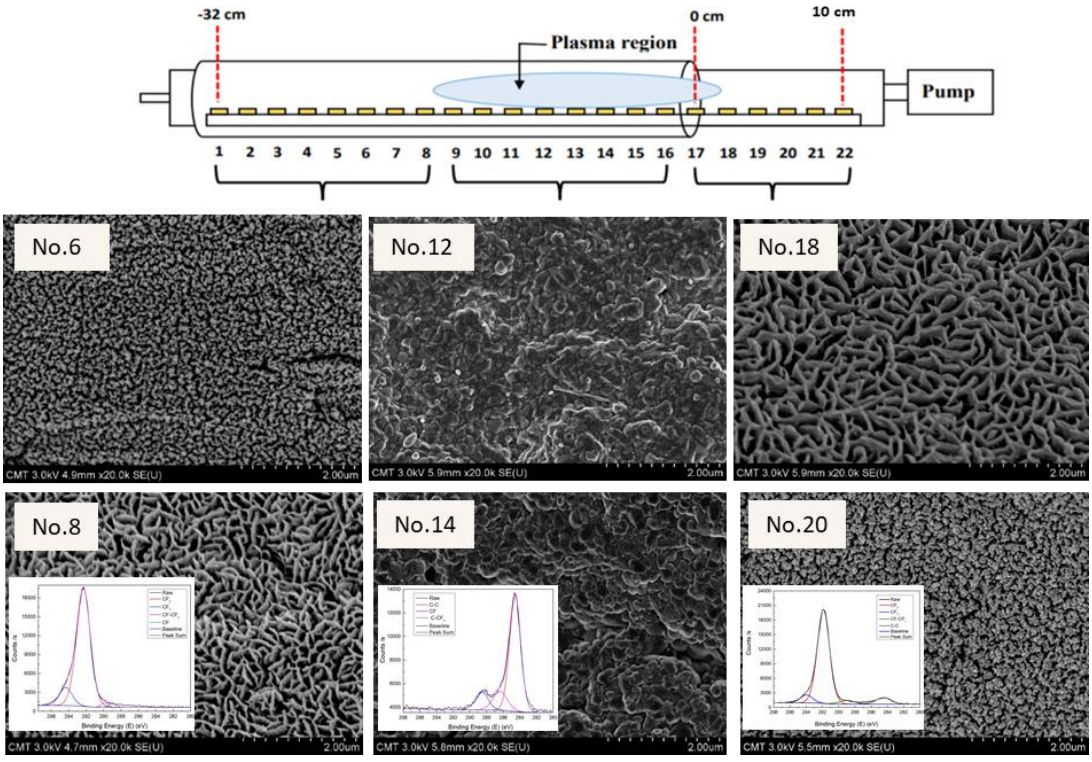

Figure 1. Surface morphology and chemical composition of the fluorocarbon films deposited in cylindrical microwave plasma reactor. The results are symmetrical to the center of plasma discharge. Along the flow direction, the deposited film changes from Teflon-like nano-particulate (No. 6) to Teflon-like nano-wall (No. 8), then to carbon-rich dense film (No. 12, 14). The diffusive behavior of this deposition process can be realized as the film changes to Teflon-like nano-wall (No. 18), then back to Teflon-like nano-particulate structure (No. 20).