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Reduction Mechanism of Surface Roughness on ArF-Photoresist Using C_5HF_7 Gas Plasma YUDAI MIYAWAKI, KEIGO TAKEDA, HIROKI KONDO, KENJI ISHIKAWA, MAKOTO SEKINE, Nagoya University, AZUMI ITO, HIROKAZU MATSUMOTO, ZEON CORPORATIO, MASARU HORI, Nagoya University — Fluorocarbon (FC) plasmas have been used in reactive ion etch processes for the fabrication of high-aspect-ratio-contact-hole on SiO_2. There are some needs, such as high selectivity over photoresist (PR), Si_3N_4 and Si, avoiding surface roughness formation on ArF- PR. C_5F_8 gas is known to improve the SiO_2 selectivity compared with C_4F_8 and conventional gas chemistries. Recently, we achieved that highly selective etching of SiO_2 against PR, Si_3N_4 and Si using a newly-designed gas, C_5HF_7, and O_2, Ar gas mixture. So far, we have investigated the etch performances and its mechanism using C_5HF_7 gas chemistry through comparison with C_5F_8 gas. In this study, we focused on the mechanism of reducing the surface roughness formation on ArF-PR during SiO_2 etching in the C_5HF_7 gas chemistry. The plasma etching time dependency of surface morphology on ArF-PR was compared with the case of C_5F_8. For $C_5F_8/O_2/Ar$ plasma, surface roughness increased. For $C_5HF_7/O_2/Ar$ plasma, RMS roughness about 2 nm was formed on the PR surface at 5 sec. As the time elapsing, surface roughness stayed constant. The RMS roughness caused by C_5HF_7 gas chemistry was lower than that of C_5F_8. Since F atoms in FC film were reduced by hydrofluorocarbon species, CxHFy, the FC polymerization was enhanced selectively on PR to form a thicker FC film that protects the PR surface from ion bombardments, while keeping the high etch rate for SiO_2.

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