A—5—4 (Invited) Laser Photochemical Processing for Microelectronics

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A number of new laser techniques for processing semiconductors have recently been demonstrated.[1] They involve: (1) the use of focused cw UV and visible laser beams to initiate localized reactions which produce deposition on, and etching or doping of, semiconductor substrates, (2) the use of pulsed UV laser beams to dope semiconductors directly and form large area p-n junctions and (3) the use of pulsed UV lasers to initiate gas-phase chemical reactions leading to the deposition of compounds. Examples of each of these processes will be discussed.

Focused cw laser beams have been used to initiate localized reactions that are either purely photolytic, mixed photolytic-pyrolytic, or purely pyrolytic. The deposition of Cd using a frequency-doubled argon-ion laser is a purely photolytic reaction, the etching of Si, in a Cl_2 atmosphere,[2] with an argon-ion laser is a mixed reaction and the deposition of polysilicon conductors on Si substrates locally heated with an argon-ion laser is a thermal one.[3] Each of these systems will be discussed briefly.

A pulsed excimer laser, operating at either 193 nm or 351 nm, has been used to dope single-crystal InP, GaAs, and Si and polysilicon.[4] In this case the laser serves both to release dopant atoms by dissociation of parent-gas molecules and to heat the substrate to allow incorporation of the dopant by liquid-state diffusion. For some gas-substrate combinations doping can be achieved even when the parent gas molecules do not absorb the laser radiation; in this case atoms are released by pyrolysis of molecules adsorbed on or striking the laser-heated surface. The laser doping technique has been used to make p-n junctions in Si and GaAs and ohmic contacts on InP. Such junctions have been used to make efficient Si and GaAs solar cells.

Photochemical initiation of reactions leading to compound formation has the potential of lowering processing temperatures, decreasing strain in deposited materials. Hg lamp sources have previously been used to initiate reaction leading to the deposition of SiO_2 and Si_3N_4.[5] Recently an ArF laser source has been used by ourselves and by other workers[6] to initiate the reaction of N_2O with SiH_4, leading to the deposition of SiO_2 on Si. Other potential laser-initiated compound formation reactions will be discussed.

REFERENCES

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