LD-5-5

CURRENT-DRIFT SUPPRESSED InP MISFETS WITH A NEW GATE INSULATOR

Osamu MIKAMI, Masamichi OKAMURA, Eiichi YAMAGUCHI, Yukihiro HIROTA
and Yoshitaka FURUKAWA
Musashino Electrical Communication Lab., NTT, Musashino-shi, Tokyo 180

INTRODUCTION Considerable research efforts have been directed toward the development of InP MISFETs using a variety of dielectric gate materials. We have investigated the low-temperature chemical vapor deposition (CVD) of P-N and related compounds using halide chemicals as reactants.1) The reaction temperature can be reduced to almost 300°C. Studies of the C-V characteristics of MIS diodes reveals that P-O-N films deposited on InP substrates using a reaction of $POCl_3$ - NH_3 have low interface state densities.

This paper describes the electrical characteristics of n-channel InP MISFETs fabricated with the P-O-N gate insulator. Remarkable suppression of drain-current drift during long-term operation ($2x10^5$sec) and relatively high effective mobility ($1000cm^2$/Vsec) can be achieved.

FABRICATION The MISFETs were prepared on semi-insulating InP substrates with a (100) orientation. The source and drain n^+ regions were formed by Si^+ ion implantation with a $2x10^{14}cm^{-2}$ dose at 200keV. The samples were then activated by a lamp-aneal process at approximately 800°C for 3min in a phosphorus atmosphere. The gate insulator was deposited using a low-temperaturew CVD process in the $POCl_3$-NH_3 system.

A schematic diagram of the reaction tube as well as the positions relative to a temperature profile are shown in Fig.1. A conventional resistance furnace was used. $POCl_3$ kept at room temperature was bubbled with Ar (flow rate of 5cc/min) and the gas was further diluted with Ar(50cc/min). NH_3 (5cc/min) was also diluted with Ar(50cc/min). These reactants were fed into the reaction tube from two entrances. The reaction temperature examined was about 400°C. Under these conditions, an amorphous insulating P-O-N film was deposited onto the substrates located in the center of the tube. The deposition time for the 0.1μm-thick films was about 20min.

RESULTS Typical output characteristics of the MISFET are shown in Fig.2. Gate length and width are about 6μm and 130μm, respectively. Effective electron mobility was estimated to be about $1000cm^2$/Vsec.

A remarkable reduction in the drain-current drift was achieved. Most n-channel InP MISFETs reported thus far suffer from severe current drift.$^{2),3)}$ The drifts in our devices are shown in Fig.3 using semi-logarithmic axes. Data are normalized with respect to the initial current $I_D(t=5\mu sec)$. For comparison, data for devices fabricated with other films are also shown. It should be noted that in the sample of P-O-N films, the drain-current remained essentially constant for a period on the order of 10^3sec. For operation beyond 10^3sec, the data are normalized with respect to the initial current $I_D(t=10^2sec)$. A current increase is seen at a gate voltage of 1V. This may originate from mobile ionic charges in the insulator. It tends to saturate after operation of about 10^5sec. Gate-voltage dependent drift characteristics are also observed in this time range. Even after $t=2x10^5$sec (55hours), however, variations in drain-current are within 10-20% of the initial value. These observations indicate that the density of the electron trapping levels in the insulator seems to be quite low in the P-O-N films.

REFERENCES 1) Y. Furukawa; submitted to Japan. J. Appl. Phys.
2) M. Okamura and T. Kobayashi; Japan. J. Appl. Phys. 19(1980)2151.
3) T. Sawada and H. Hasegawa ; Electron. Lett., 18(1982)742.

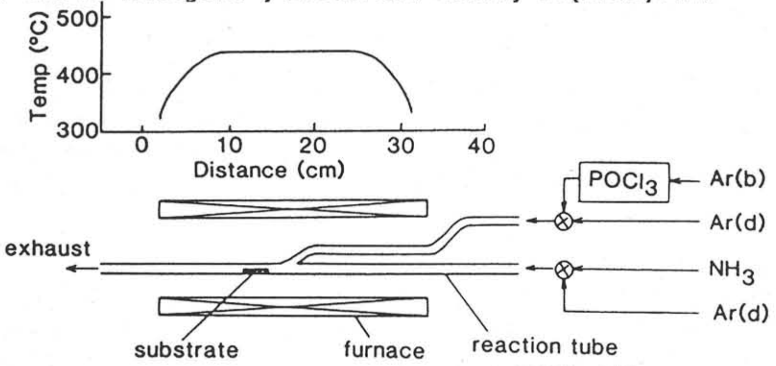

Fig. 1 Deposition scheme of $POCl_3$-NH_3.

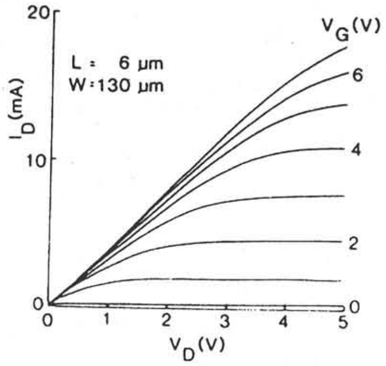

Fig. 2 I_D-V_D characteristics.

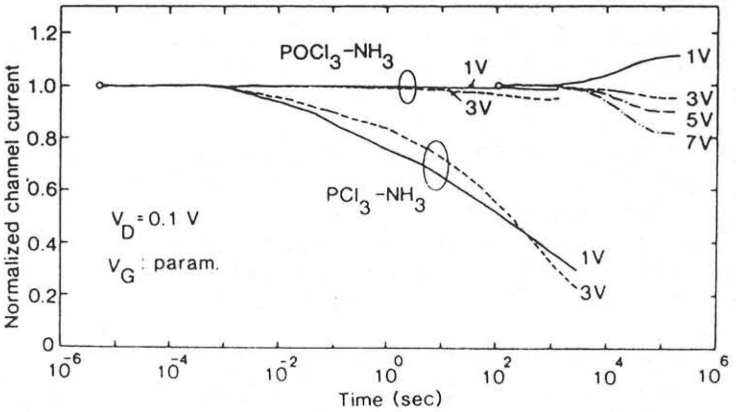

Fig. 3 Drain-current vs. time characteristics.