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Tin Diffusion from Doped Oxides for Fabricating GaAs Microwave Devices

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Doped and undoped spun-on silicafilms /1/ have been used as diffusion sources and passivation films, respectively, for open tube diffusions into semiinsulating (Cr-doped) GaAs. The oxide layers are formed by thermal decomposition of liquid emulsions, which are spun-on by a conventional photoresist-spinner.

In our case two oxide layers have been used, first a Sn-doped layer and second a protective undoped one.

Diffusions were carried out at 900°C for 45 min in a pure nitrogen ambient. After diffusion no destruction of the GaAs-surface has been observed.

To obtain the doping profiles, we etched some steps and determined the concentration via C-V-measurements with Au-Schottky-diodes. The electron concentration remains constant ($n= 1.5\cdot10^{18}$ cm^{-3}) to a depth of about 0.16 µm. The measured drop in the electron concentration (down to $10^{16} cm^{-3}$) is comparable with theoretical calculations under the assumption of a rectangular-shaped doping profile. The profiles are similar to those previously reported on As-diffusions into silicon /2/.

Theoretical calculations correlate them to concentration-depending diffusion coefficients /3/. The results of Van der Pauw measurements are consistent with C-V-data. The Hall-mobility has been determined to be 1700 cm^2/Vs.

From such layers we have prepared Schottky-Gate Field Effect Transistors (MeSFETs) with 1.3 µm gate-length - as far as we know the first GaAs-MeSFET with diffused channel /4/. The transconductance (g_m> 100 mmho/mm) of these FET are comparable to results on epi-channel and ion-implanted-channel devices.

Contrary to epitaxy or ion implantation, the open tube diffusion is a much simpler process, especially of interest for mass production of integrated circuits on GaAs. Since selective diffusion of dopants in GaAs from silica films is possible /5/, completely planar microwave devices have become possible. More details of the technological processes and the device properties will be presented.

/1/ Demesol Emulsions; Demetron GmbH, Fed.Rep.Germany

/2/ K.Reindl; Spun on Arsenosilica Films as Sources for Shallow Arsenic Diffusions with High Surface Concentration,Sol.St.El.16,(1973),181-189

/3/ W.v.Münch, "Technologie der GaAs-Bauelemente",Springer Berlin (1969)

/4/ H.Dämbkes, N.Arnold, K.Heime, GaAs Schottky-Gate Field Effect Transistors with Diffused Channel, to be published

/5/ N.Arnold, Diffusion in III-V-Semiconductors, annual research report 1978 of this laboratory

FIGURES

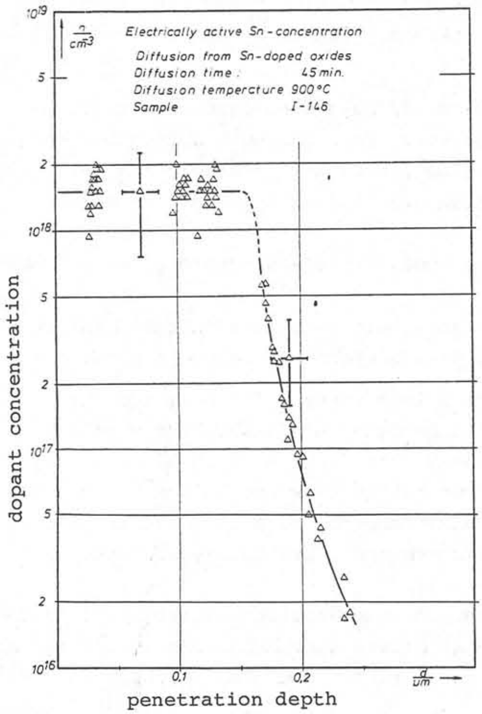

Figure 1

Dopant concentration profile determined by C-V-measurements

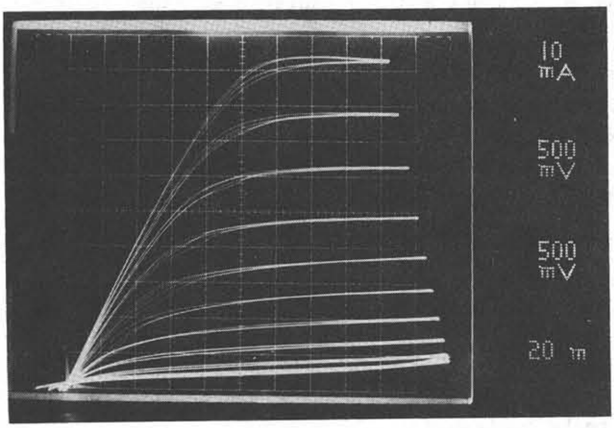

Figure 2

I-V-characteristics of a diffused-channel FET

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$n=1.3x10^{18}cm^{-3}$

$L_G=1.3$ /um, $W_G=300$ /um

$g_{max}=32$ mmho

$g_{max}=107$ mmho/mm