

Er sources in OMVPE growth of ErP

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In the organometallic vapor phase epitaxy (OMVPE), the selection of source materials is very important. The vapor pressure (from several tenths to a few Torr) at a reasonable temperature (preferably lower than RT since additional heating of the lines is not necessary) is required. Also, liquid state of the source at that temperature is favorable because the source is carried by hydrogen saturated with the source gas by bubbling. For example, TMGa that is one of the most popular Ga sources in OMVPE has a vapor pressure of 0.7 Torr at 0°C, and it is usually controlled to grow 1 ML (monolayer)/sec.

Available Er sources at present are (MeCp)₃Er (trimethylcyclopentadienylerbium), Er(DPM)₃ (trisdiethylaluminummethanatoerbium), and (i-PrCp)₃Er (trisisopropylcyclopentadienyl-erbium). Unfortunately, all of the Er sources have higher melting points and the vapor pressures are not very high as listed in Table 1. To use these sources all the lines for ErP flow must be heated at a higher temperature than that of the source.

From our experiments, 1 ML of ErP was found to grow using (MeCp)₃Er and TBP for 20 min[1]. In this experiment the temperature of and the hydrogen flow rate through (MeCp)₃Er were kept at 100°C and 125 sccm, respectively. In the case of Er(DPM)₃ a similar doping efficiency in InP was obtained at 40°C and 125 sccm. However, the growth of ErP was not observed at all with Er(DPM)₃ and TBP. We have now installed (i-PrCp)₃Er into an OMVPE growth system, by which it is expected that 1 ML growth of ErP for 1 second is achieved with 125 sccm hydrogen flow for (i-PrCp)₃Er at 100°C. It is also anticipated that the large molecules of these Er sources (Molecular weights are 405~720, while those of TMin and TBP are 160 and 90, respectively.) tend to remain in the lines. It makes an abrupt switching of the gases difficult using regular valves and sequential supply of source gases. Considering these factors, a newly designed reactor chamber with a separate gas line system is now being fabricated.

The growth habit of ErP with different source gases and the design and set up of the new reactor will be presented and discussed.

Table 1 Properties of several Er sources

Er sources	(MeCp) ₃ Er	Er(DPM) ₃	(i-PrCp) ₃ Er
Molecular formula	(CH ₃ C ₅ H ₄) ₃ Er	Er(C ₁₁ H ₁₉ O ₂) ₃	(I-C ₃ H ₇ C ₅ H ₄) ₃ Er
Molecular weight	405	720	489
Melting point	133°C	168-171°C	57°C
Boiling point	-	-	160°C
Vapor pressure	10 ⁻⁴ Torr @150°C	0.1 Torr @160°C	0.4 Torr @160°C

[1] L. Bolotov, Y. Takeda, A. Nakamura et al.: Jpn. J. Appl. Phys., **36**, L1534 (1997).