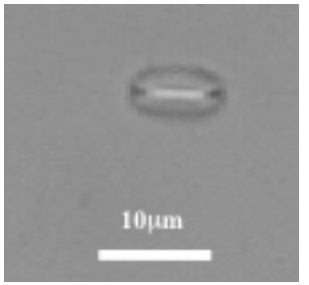
# Comments on problem 200-13




An Oval defect

During GaAs MBE there is a strong tendency to form droplets of Ga on the surface of the GaAs.
They are clearly linked to oval defects observable in a microscope.
They constitute a serious problem to fabrication of devices.
Without necessarily identifying the reasons for the defect discuss with the help of the phase diagram (Fig. 2.2) how you could

a) avoid these droplets
b) find out something about their origin
c) explain why thermodynamics favor the formation of droplets

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a) First obvious answer/guess may be you can remove Ga droplets by increasing the As:Ga flux during growth..

b) If a) was correct, one would grow with increasing As flux, and see if the oval defects went away

Actually they will not go completely away – in most cases.

Comment on a) The phase diagram shows the phase GaAs is very narrow. At first sight indicating we have to hit the flux extremely accurate. So if we increased As flux, we might get rid of Ga droplets, but we should get As precipitates. This As would not melt according to the phase diagram, but it would be in solid phase, according to the phase diagram.

c) The phase diagram 2.2 shows that - at 1 atm pressure, Ga melt ( the droplet)is in equilibrium with GaAs for temperatures above 30 C.

The growth of stochiometric GaAs is possible because of high vapor pressure of As ( or As2 + As4) and because of the sticking coefficient is high for Ga atoms. So the arrival flux of As and Ga do not need to be 1:1

The suggestions in a) is good, but carrying out the experiments mentioned in b) will not eliminate oval defects.

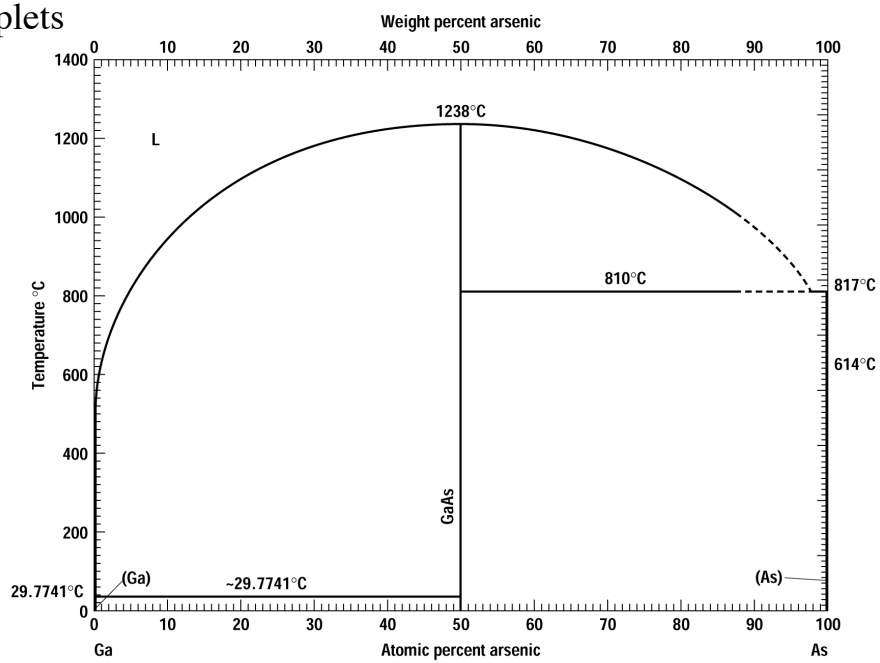


Figure 2.2 Phase diagram for GaAs *(courtesy of ASM International).*

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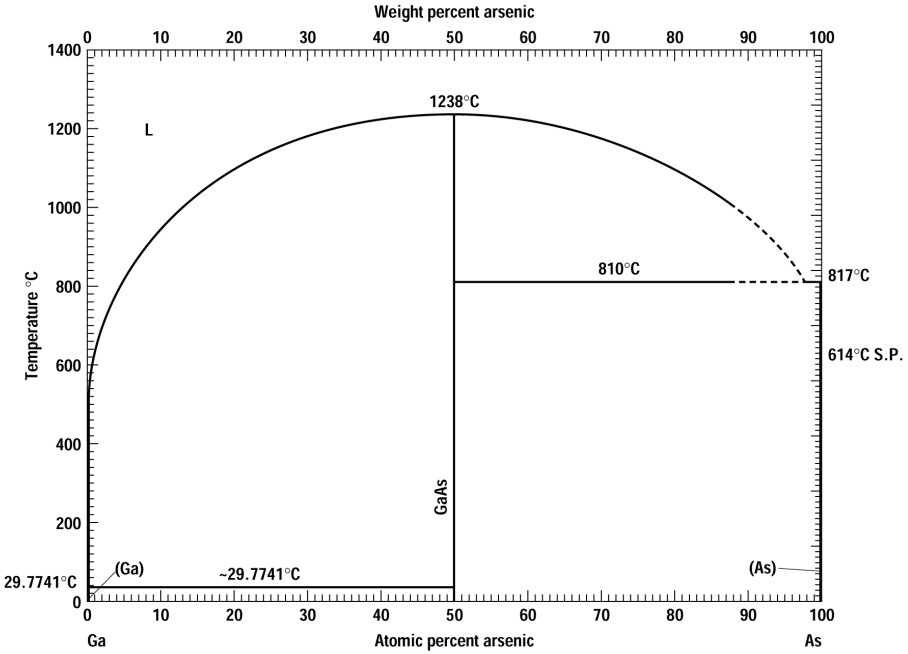
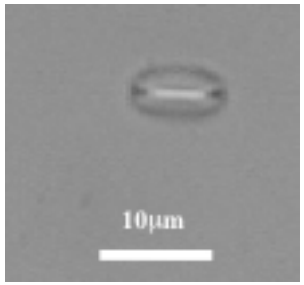



Figure 2.2 Phase diagram for GaAs *(courtesy of ASM International).*

Oval defects are associated with Ga droplets on the GaAs surface during MBE growth.

The phase diagram also suggest that once having a Ga droplet, if the flux of As is sufficiently large, the Ga droplet may go away. It will transform into GaAs and solid As - at reasonable growth temperatures.




An Oval defect

It may also be interesting with a few quotes from some publications: :" The variety of reasons of oval defect occurrence causes that the methods proposed to reduce their density frequently contradict one another. To overcome the oval defect problem the origin of the defects has been investigated". "It appears now that oval defects occur mainly due to gallium oxides present in the gallium effusion cell, gallium spitting from the cell and the particle contamination of the substrate surface" Klima et al. Cryst. Res.Technol. 34 (1999) 683".