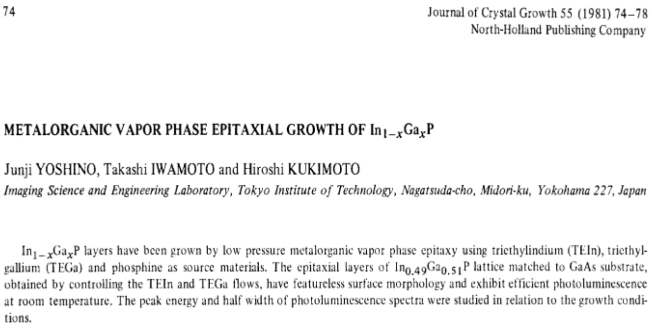
実用化された研究成果

化学気相成長法薄膜成長（MO-CVD）装置

通信用の高周波半導体デバイスや半導体発光デバイス（LED, LD）に用いられるGaAs系、InP系、GaN系などの化合物半導体は有機金属化合物とアルシン、フォスフィン、アンモニアなどを原料として熱分解して成長させる。この成長技術は1980年ごろから注目されるようになった。

柊元研究室ではこの技術のもつ将来性をいち早く見抜き、わが国のMO-CVD法による半導体薄膜の作製のパイオニアとして研究が推進された。 原料となる有機金属化合物は常温で液体のものが多く、また、大気に触れると容易に酸化されるなど、従来のCVD法に用いられる原料と比べて取り扱いが難しく、また、原料物質の調達、CVD装置の設計、ガスの供給方法を含めて、研究は手探りの状態であった。特に、装置設計、ガスの供給法などは不明な点が多く、CVD装置メーカーとの密接な協力の下で研究が進められた。こうして得られた成果はわが国でのMO-CVD技術の普及に貢献した。

現在の高速通信デバイス、半導体レーザなどの工業的製造には本技術が広く用いられており、今や社会基盤となった今日の情報通信技術の発展に大きな役割を果たした。



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METALORGANIC VAPOR PHASE EPITAXIAL GROWTH OF $In_{1-x}Ga_xP$

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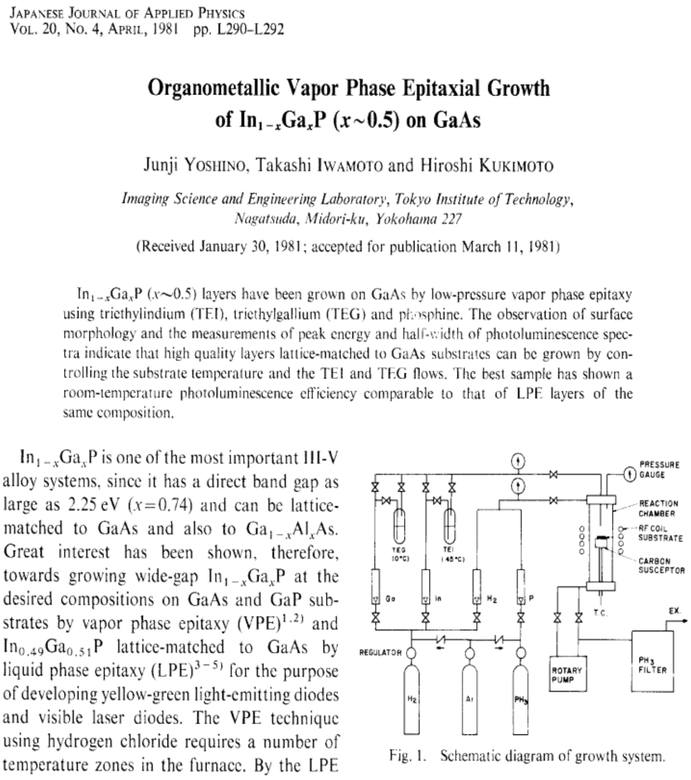
$In_{1-x}Ga_xP$ layers have been grown by low pressure metalorganic vapor phase epitaxy using triethylindium (TEIn), triethylgallium (TEGa) and phosphine as source materials. The epitaxial layers of $In_{0.49}Ga_{0.51}P$ lattice matched to GaAs substrate, obtained by controlling the TEIn and TEGa flows, have featureless surface morphology and exhibit efficient photoluminescence at room temperature. The peak energy and half width of photoluminescence spectra were studied in relation to the growth conditions.



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Organometallic Vapor Phase Epitaxial Growth of $In_{1-x}Ga_xP$ ($x\sim0.5$) on GaAs

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$In_{1-x}Ga_xP$ ($x\sim0.5$) layers have been grown on GaAs by low-pressure vapor phase epitaxy using triethylindium (TEI), triethylgallium (TEG) and phosphine. The observation of surface morphology and the measurements of peak energy and half-width of photoluminescence spectra indicate that high quality layers lattice-matched to GaAs substrates can be grown by controlling the substrate temperature and the TEI and TEG flows. The best sample has shown a room-temperature photoluminescence efficiency comparable to that of LPE layers of the same composition.

$In_{1-x}Ga_xP$ is one of the most important III-V alloy systems, since it has a direct band gap as large as 2.25 eV ($x=0.74$) and can be lattice-matched to GaAs and also to $Ga_{1-x}Al_xAs$. Great interest has been shown, therefore, towards growing wide-gap $In_{1-x}Ga_xP$ at the desired compositions on GaAs and GaP substrates by vapor phase epitaxy (VPE)[1,2] and $In_{0.49}Ga_{0.51}P$ lattice-matched to GaAs by liquid phase epitaxy (LPE)[3-5] for the purpose of developing yellow-green light-emitting diodes and visible laser diodes. The VPE technique using hydrogen chloride requires a number of temperature zones in the furnace. By the LPE

Fig. 1. Schematic diagram of growth system.