利用光激發薄膜狀表面氮化銦與金字塔狀表面氮化銦產生兆赫輻射

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摘要

我們利用時域兆赫及光譜儀技術(THz-TDS)研究氮化銦(InN)材料的兆赫輻射發射機制，如漂移電流、擴散電流造成之瞬時電流和非線性光整流效應，我們也分析了其在兆赫波段的介電常數和電導率。

本文中探討有機金屬化學氣象沉積法製成之氮化銦薄膜及金字塔結構之光激發兆赫輻射中的瞬時電流效應可以忽略，藉由結合菲涅耳方程式、考慮載子吸收和非線性效應(光整流)的貢獻，我們可以很良好地解釋太赫茲電場的泵浦入射角、泵浦極化角和泵浦功率的趨勢關係。在實驗結果中，我們發現薄膜狀表面氮化銦和金字塔狀表面氮化銦的差異具有以下現象。第一，來自金字塔狀表面氮化銦表面的太赫茲輻射在低頻範圍內具有較優良的表現。第二，在泵浦偏振趨勢分析方面，薄膜狀表面氮化銦在偏振角為 90^0(TE 波)時具有最低的太赫茲產生效率，但金字塔狀表面氮化銦的趨勢則相反。第三，在泵浦功率趨勢分析方面，我們發現金字塔狀表面氮化銦發射之兆赫輻射更容易達到飽和值。

在優化了氮化銦表面的太赫茲輻射功率後，可以獲得最佳泵浦入射角~55^0，最佳泵浦極化角對薄膜狀樣品~0^0、金字塔狀樣品~90^0，其轉換效率可達到 50 左右的訊噪比。

Optically-excited THz emission from InN thin films and pyramids

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Abstract

THz emission mechanism from Indium Nitride (InN) such as drift current, diffusion current caused photocurrent surge and optical rectification effect is investigated by the setup of Time-Domain Spectroscopy in THz range (THz-TDS). We also analyzed the complex dielectric constant and complex conductivity of InN in THz radiation range.

In this thesis, photocurrent surge effect is negligible when we consider THz radiation from optically excited Film surfaced InN and pyramids surfaced InN which is grown by metalorganic chemical vaper deposition (MOCVD) method. By combining the Fresnel equation, free carrier absorption and nonlinear effect (Optical rectification), we can well explain pump incident angle-, pump polarization angle- and pump power- dependence of THz electric field. In the experimental results, we found the difference between film surfaced InN and pyramids surfaced InN has the following phenomena. First, the THz radiation from pyramids surfaced InN has higher performance at the low frequency range. Second, in the pump polarization dependence, the film surfaced InN has the lowest THz generation efficiency with polarization angle at 90^0 (TE-wave) but the trend of pyramids surfaced InN is opposite. Third, in the pump power dependence, the THz emission from pyramids surfaced InN is easier to get saturated.

After optimizing the power of THz radiation from InN surface, we can get the optimal pump incident angle ~ 55^0, optimal pump polarization angle ~0^0 (for film sample) ~90^0 (for pyramids sample) and the transfer efficiency can achieve the signal to noise ratio around 50.