



# Electromodulation spectroscopy of dilute nitride quantum well structures

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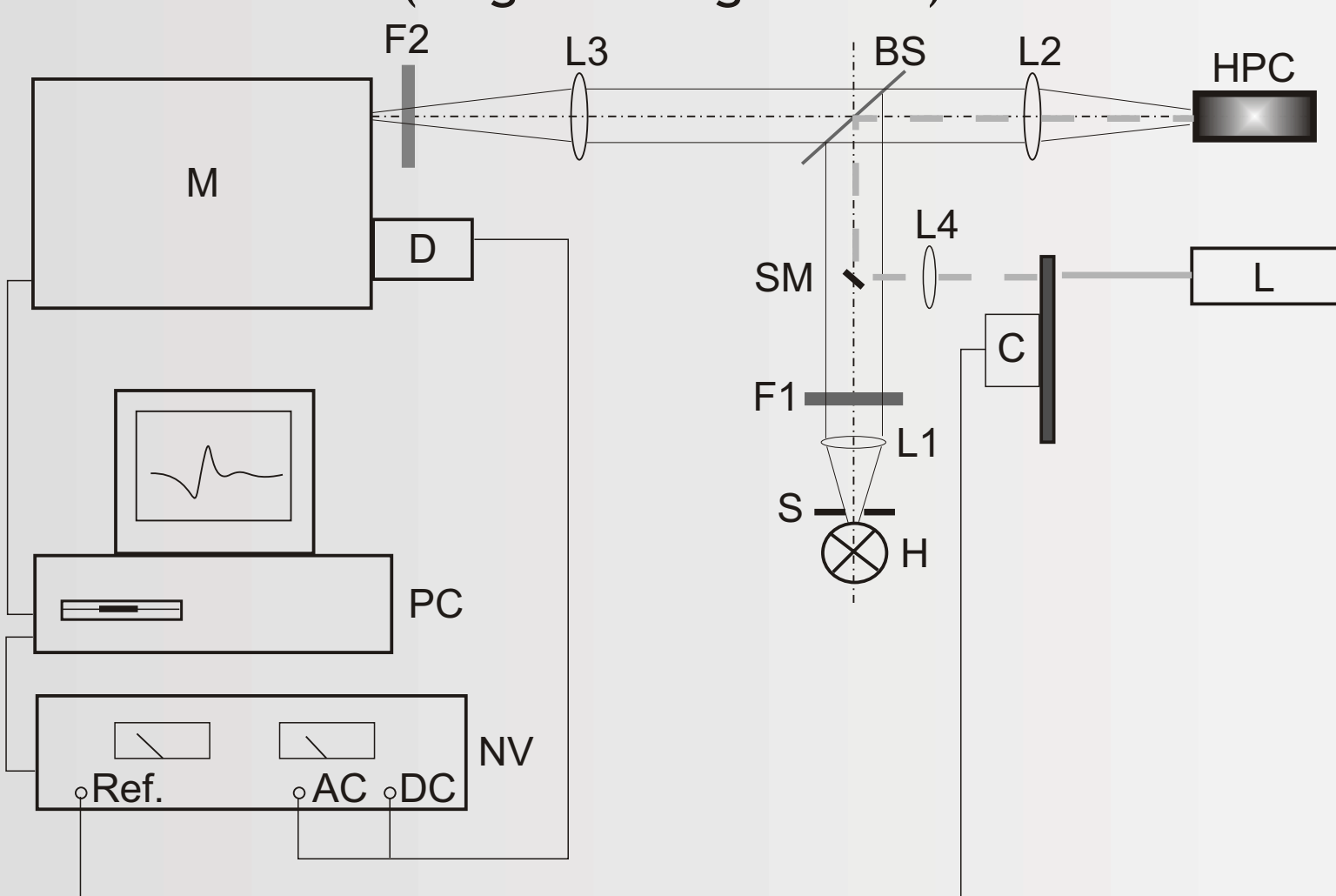
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**Abstract.** Electromodulation (EM) spectroscopy has been applied to study of step-like GaInNAs/GalnNAs/GaAs double quantum well (DQW) structures grown by molecular beam epitaxy. PR features related to optical transitions in the active part of the step-like QW structure, i.e. GaInNAs/GalnNAs QW, as well as EM features related to transitions above the step-like barrier (SLB) have been clearly observed and analysed in this paper. The analysis of the QW transitions gives information about the number of confined states in the active part of the step-like QW structure. In addition, the analysis of the second portion of PR signal gives information about the band gap energy of the SLB and optical transitions between hole and electron levels confined above the SLB.

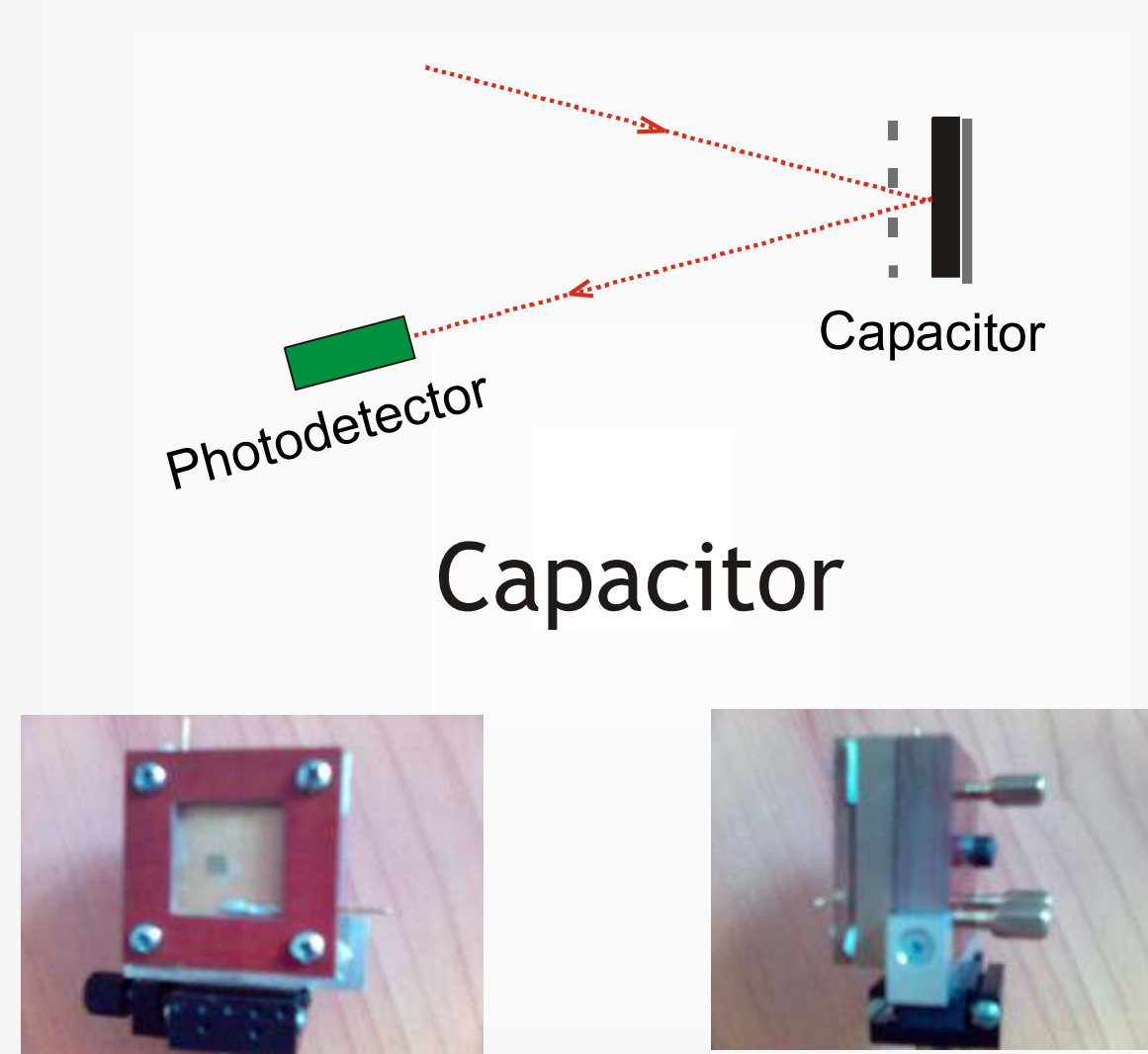
### Photoreflectance set-up (bright configuration)



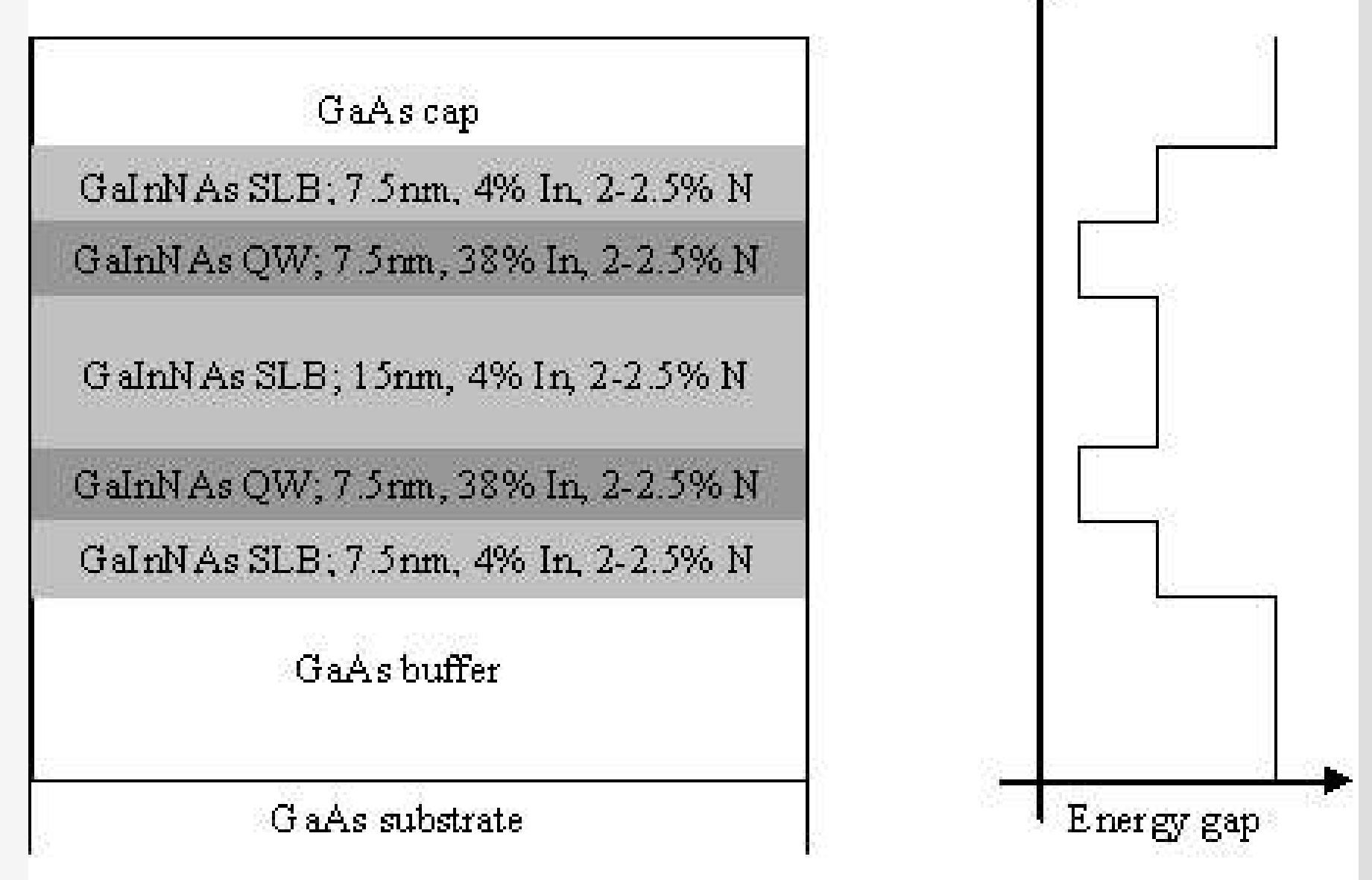
Experimental set-up for PR measurements in the so-called 'bright configuration' at various hydrostatic pressure. H - Halogen lamp; S - Slit; L1, L2, L3, L4 - Lens; F1, F2 - Filters; SM - Small Mirror; BS - Beam Splitter; HPC - High Pressure Cell; M - Monochromator; D - Detector; NV - Nanovoltmeter (Lock-in); L - Laser; C - Chopper; PC - Personal Computer.

### Introduction

#### Contactless electroreflectance mode

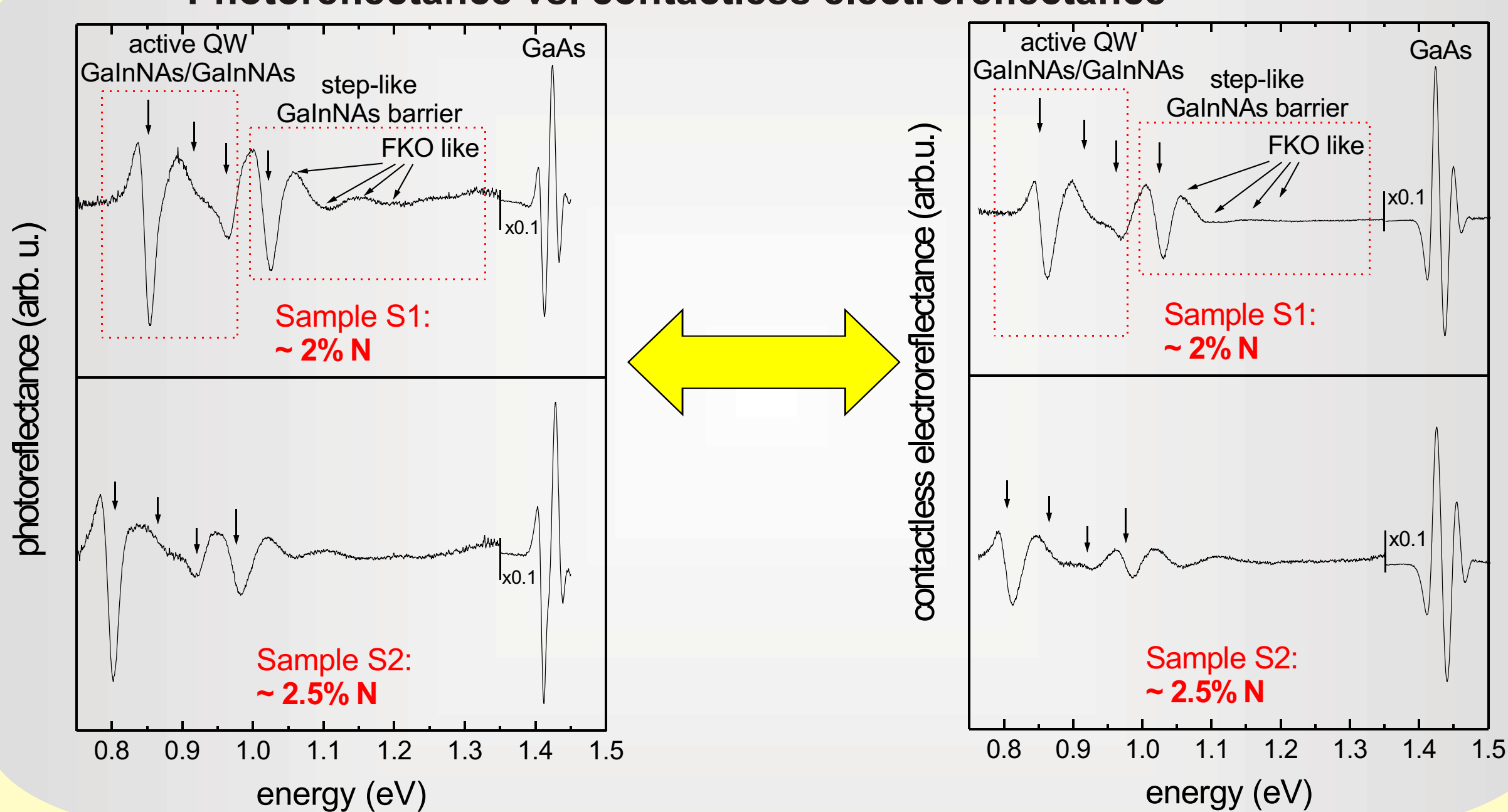


### Samples

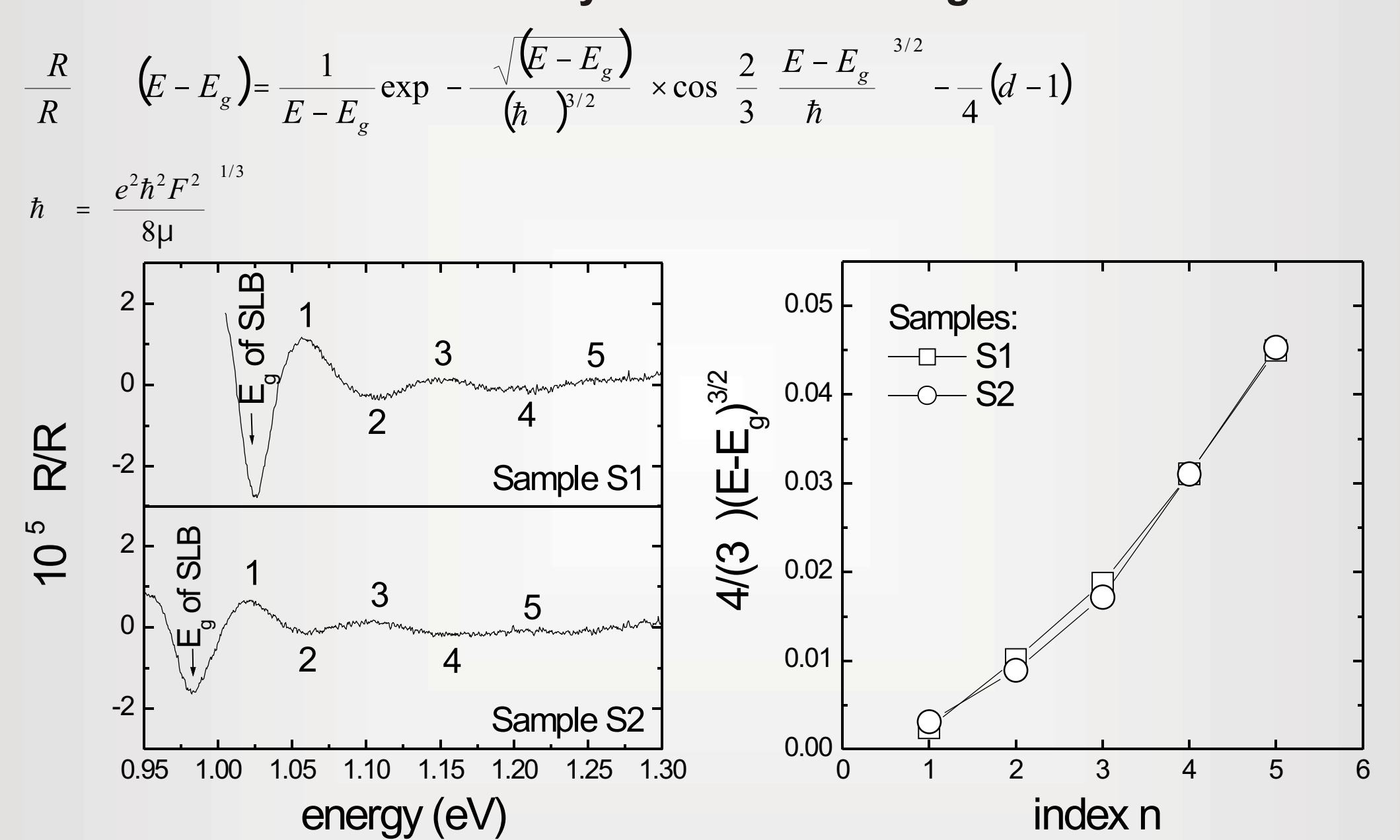


## Results and analysis

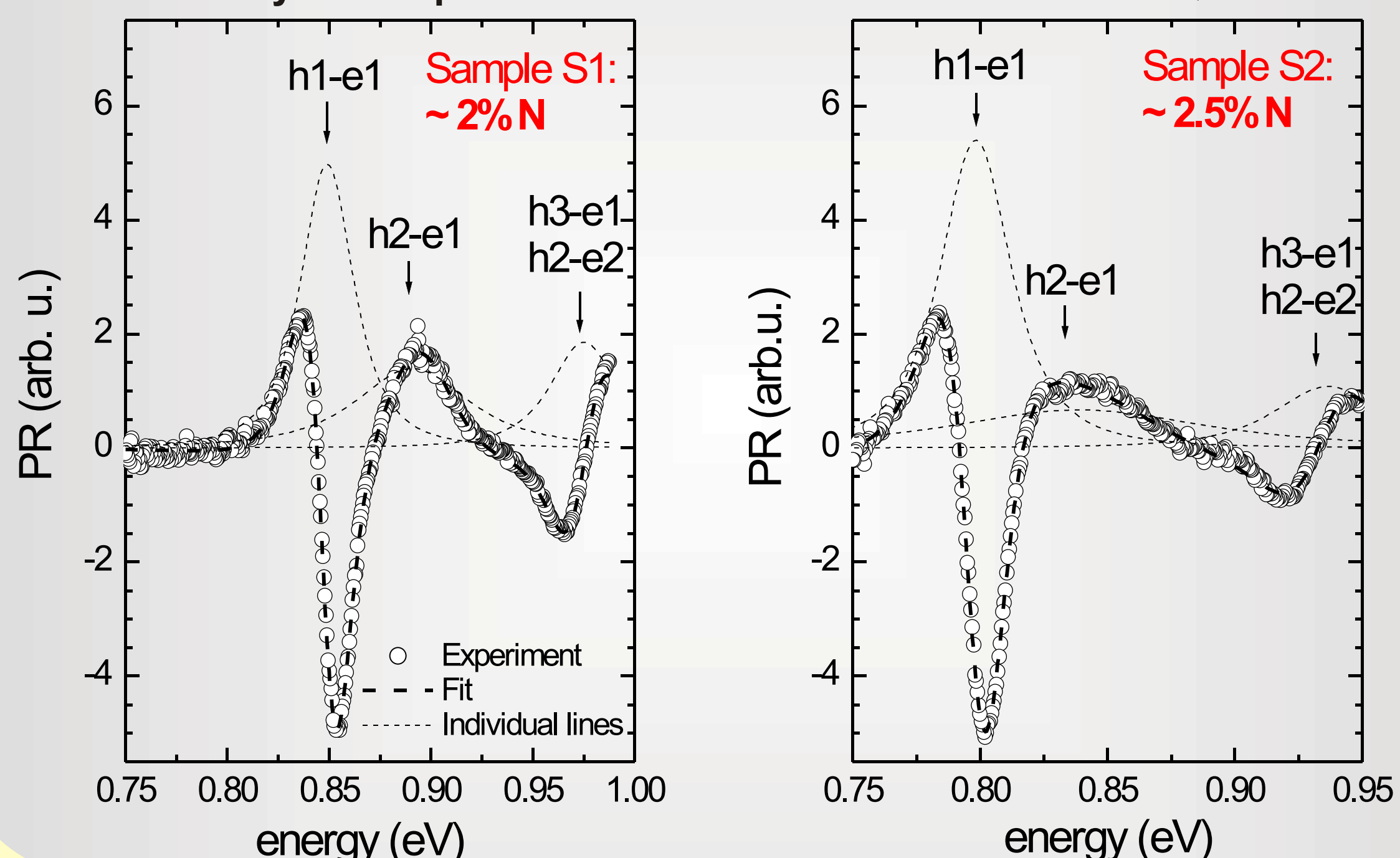
### Photoreflectance vs. contactless electroreflectance



### Analysis of FKO-like signal

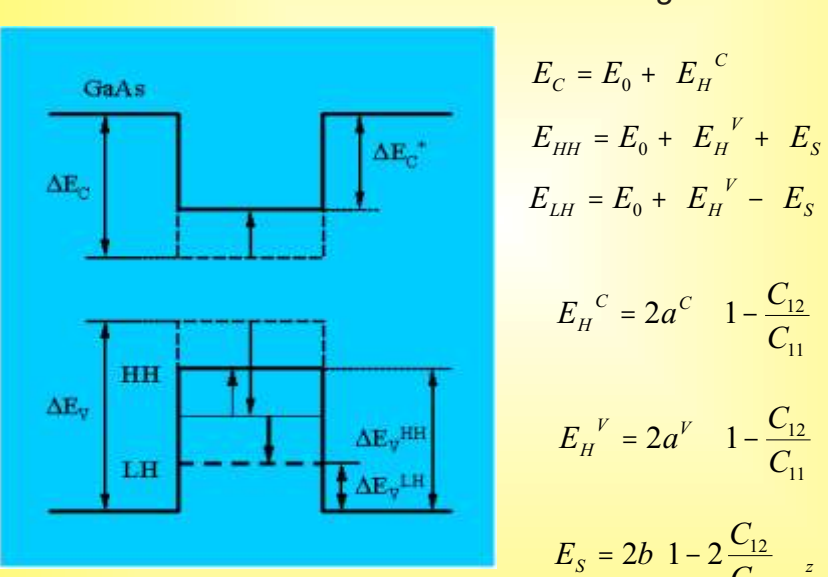


### Analysis of optical transitions in GaInNAs/GalnNAs QW



### Theoretical approach

$Q_c = \frac{E_c}{E_c + E_v}$   
We take into consideration strain effects according to textbook formulas:



### Energy levels for the GaInNAs/GalnNAs/GaAs step-like QW structure

