Wrocław University of Technology

Centre for Advanced Materials and Nanotechnology

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Optical Investigation of AlGaN/GaN HFET transistor structures

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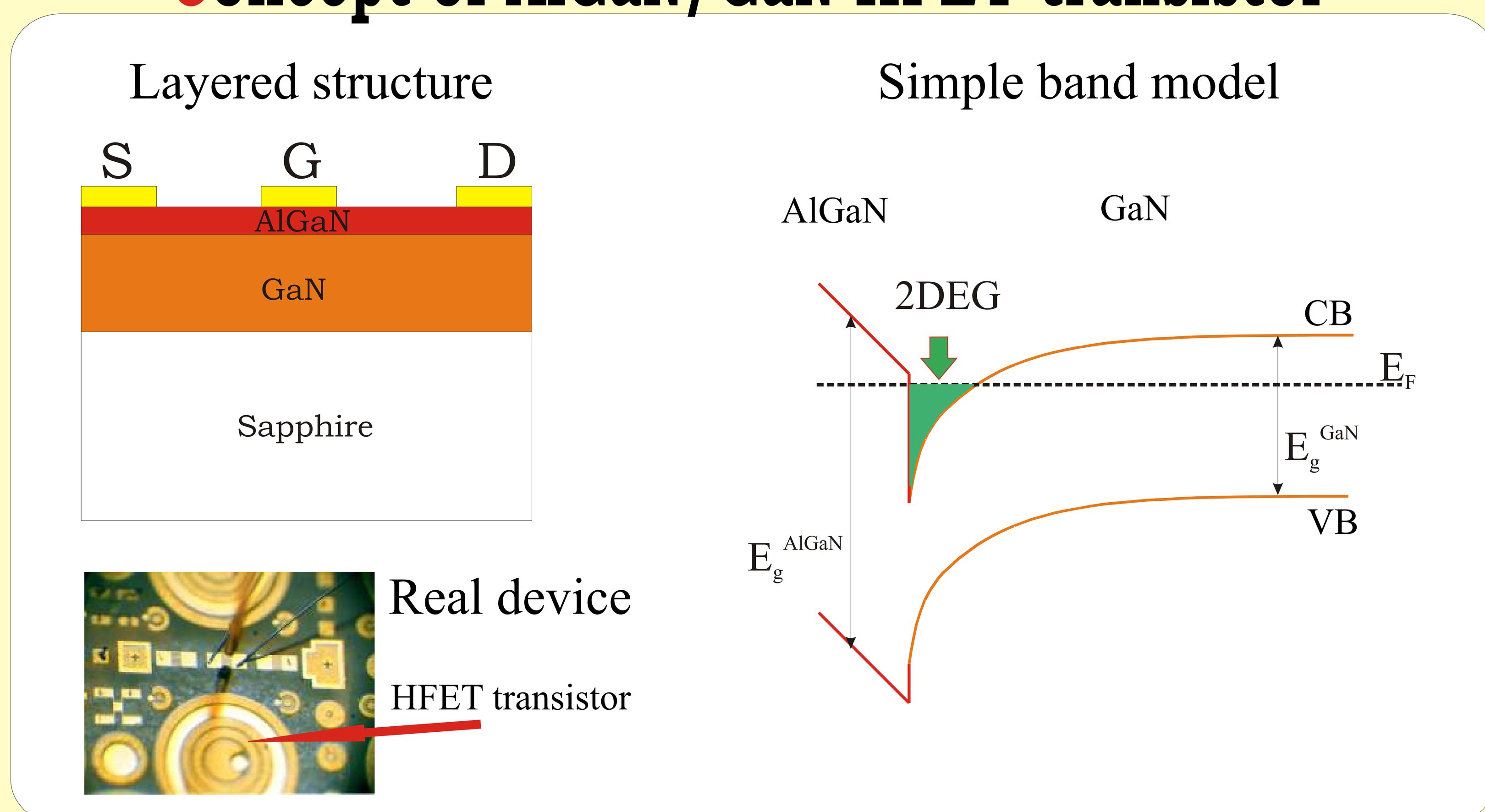
Concept of AlGaN/GaN HFET transistor

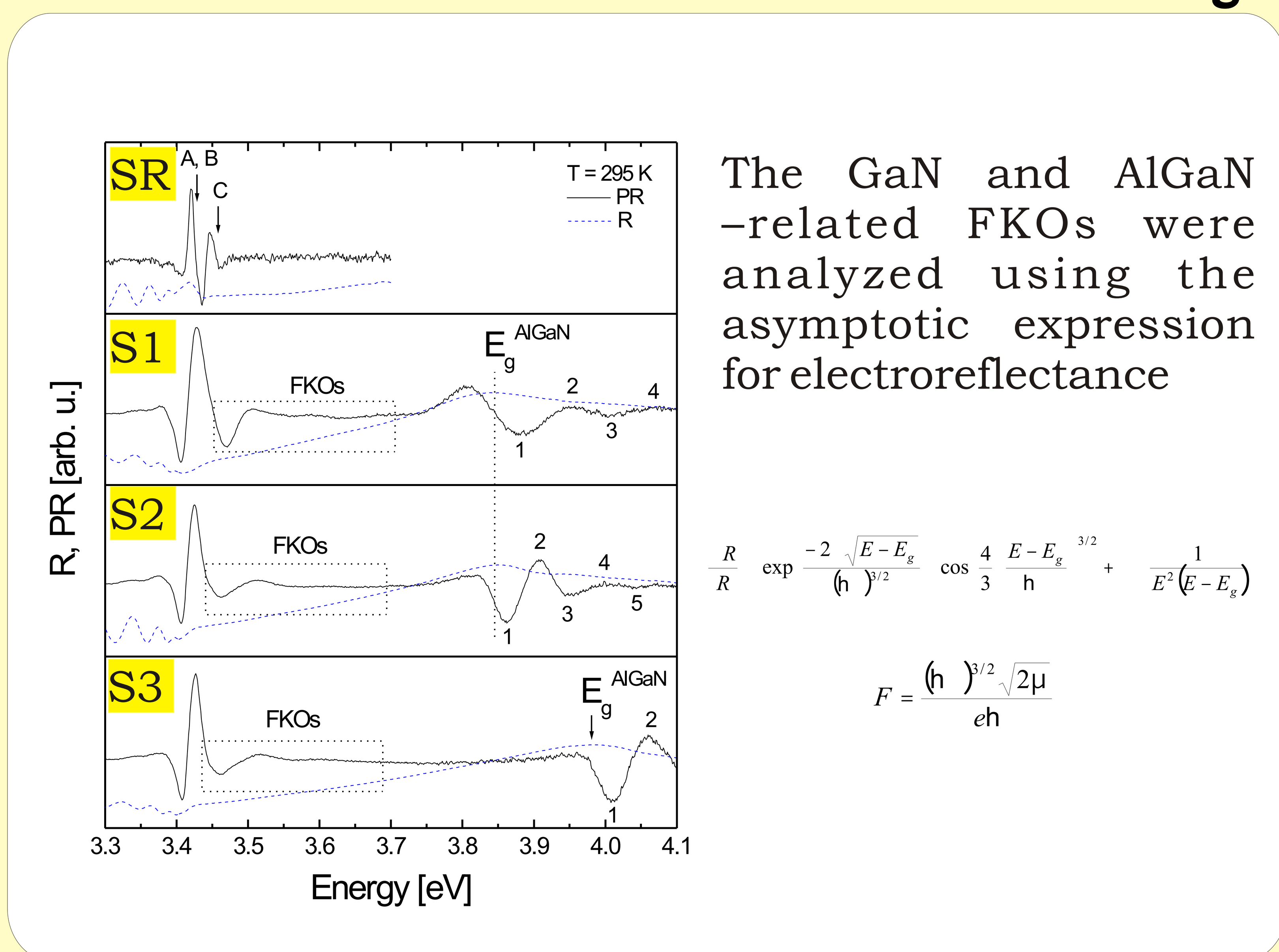


Investigated HFETs structures

Sample Id.	Layer thickness of AlGaN [nm]	GaN [μm]	Substrate	Doping	Al content in AlGaN layer[%]
S1	30	2	Sapphire	no	20
S2	45	2	Sapphire	no	20
S3	45	2	Sapphire	no	25
S4	30	2	Sapphire	AlGaN : Si, $N_D=10^{19}cm^{-2}$	
S5	30	2	Sapphire	no	
SR	-	2	Sapphire	no	

All structures were grown using MOVPE technique. Main layered AlGaN/GaN structure were grown after deposition of ~20nm low temperature buffer layer on sapphire.

Photoreflectance ivestigations of internal electric fields

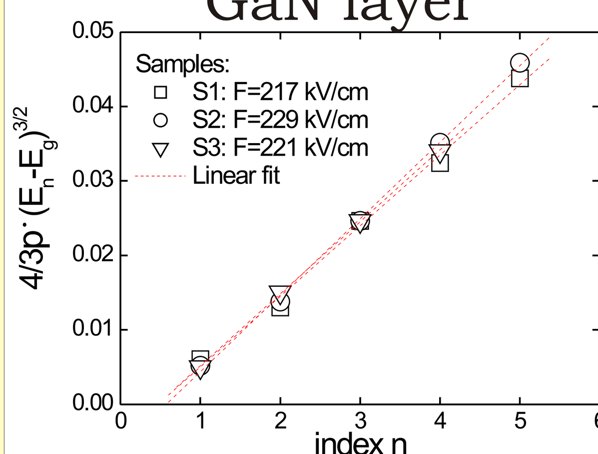


The GaN and AlGaN –related FKOs were analyzed using the asymptotic expression for electroreflectance

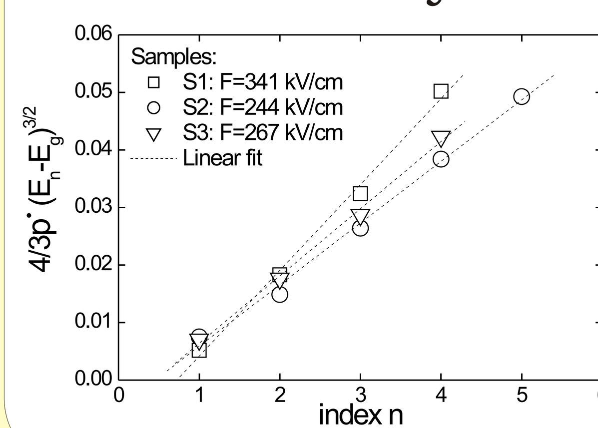
$$\frac{R}{R} \quad \exp\frac{-2\sqrt{E-E_g}}{(h)^{3/2}} \quad \cos\frac{4}{3}\frac{E-E_g}{h}^{3/2} + \frac{1}{E^2(E-E_g)}$$

$$F = \frac{(h)^{3/2}\sqrt{2\mu}}{eh}$$

Built-in electric field in GaN layer



Built-in electric field in AlGaN layer



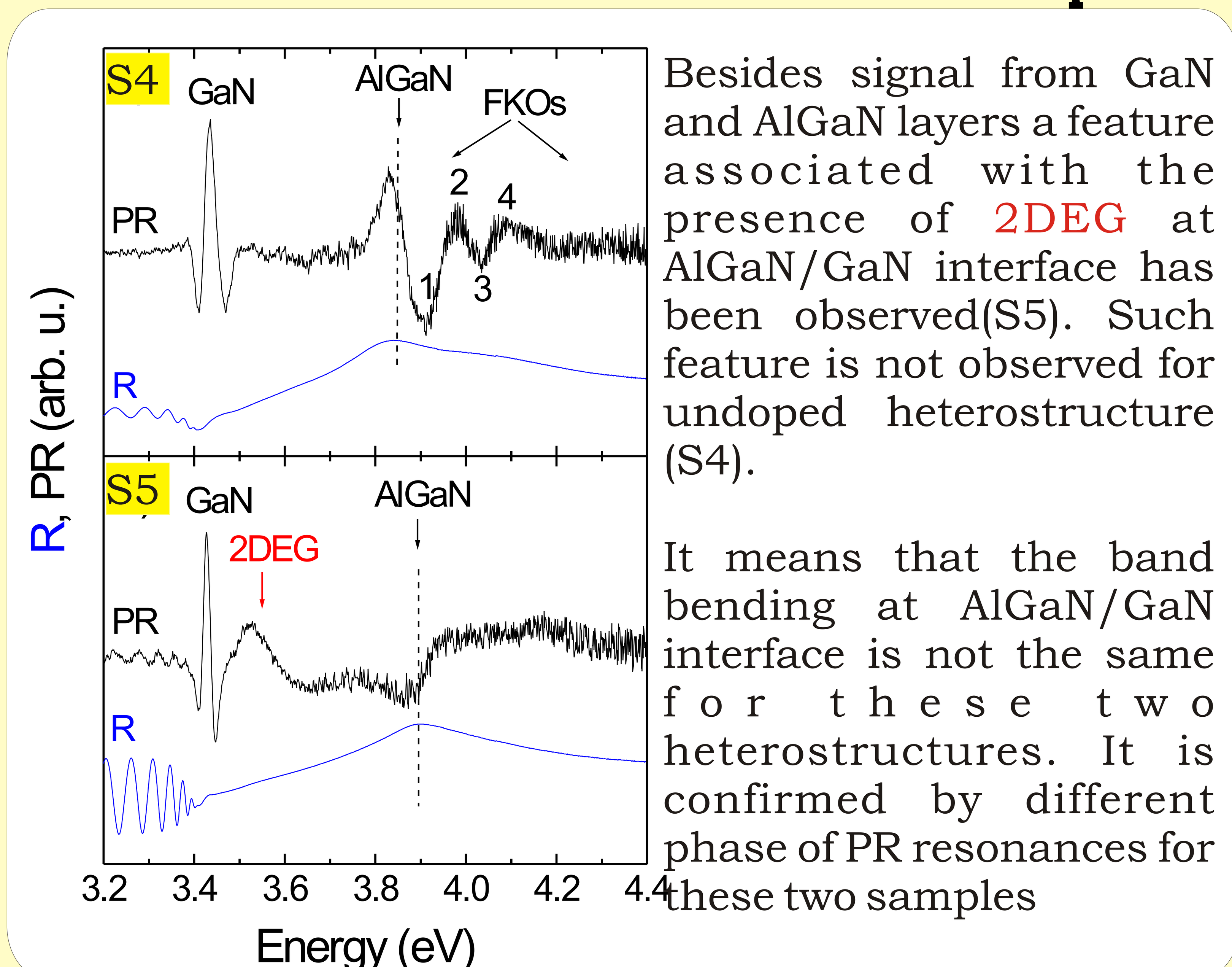
Obtained values of the electric field correspond to the band bending at AlGaN/GaN interface

Sample Id.	Layer thickness of AlGaN [nm]	Al content in AlGaN layer[%]	Electric* Field [kV/cm]
S1	30	20	340
S2	45	20	240
S3	45	25	270

* built-in AlGaN layer

For AlGaN/GaN heterostructures with the increase of AlGaN thickness the electric field decreases

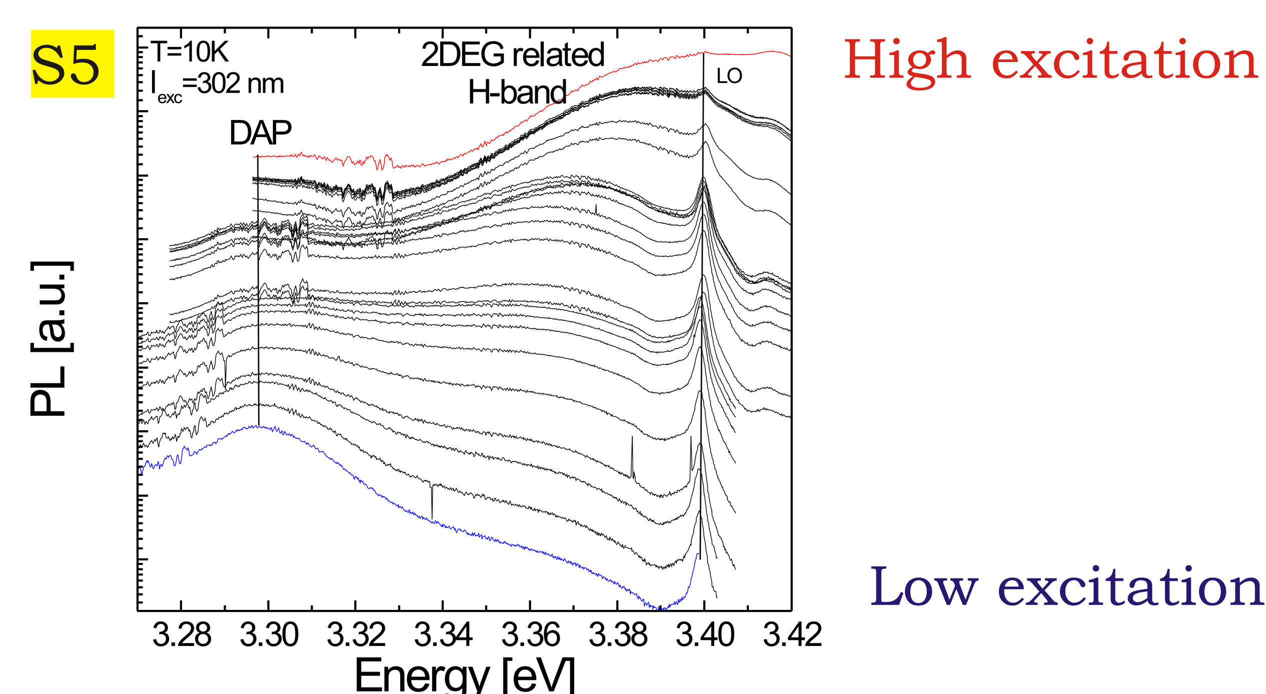
Photoreflectance and photoluminescence investigations of 2DEG



Besides signal from GaN and AlGaN layers a feature associated with the presence of 2DEG at AlGaN/GaN interface has been observed(S5). Such feature is not observed for undoped heterostructure (S4).

It means that the band bending at AlGaN/GaN interface is not the same for these two heterostructures. It is confirmed by different phase of PR resonances for these two samples

Photoluminescence spectra with pump power of 2DEG



Presence of the 2DEG at heterointerface has been confirmed in photoluminescence spectroscopy for Si-doped sructure;

The 2DEG related transition has been observed between LO phonon replica and DAP related transition