

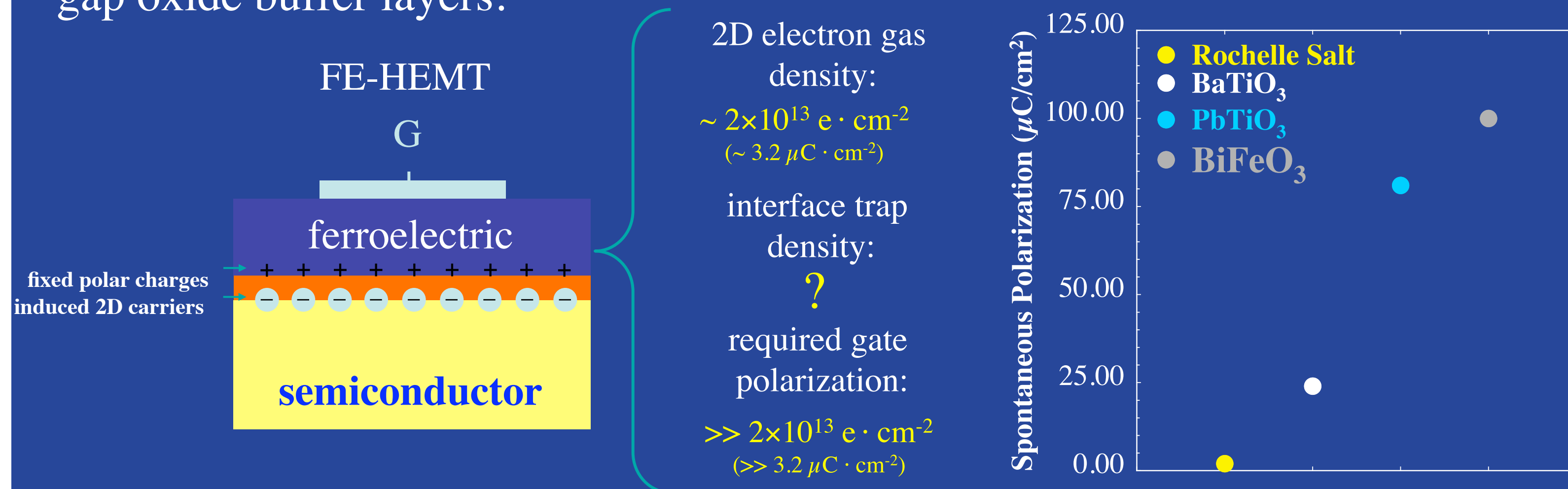
Growth of Wide Band-Gap Oxides on GaN by Molecular-Beam Epitaxy

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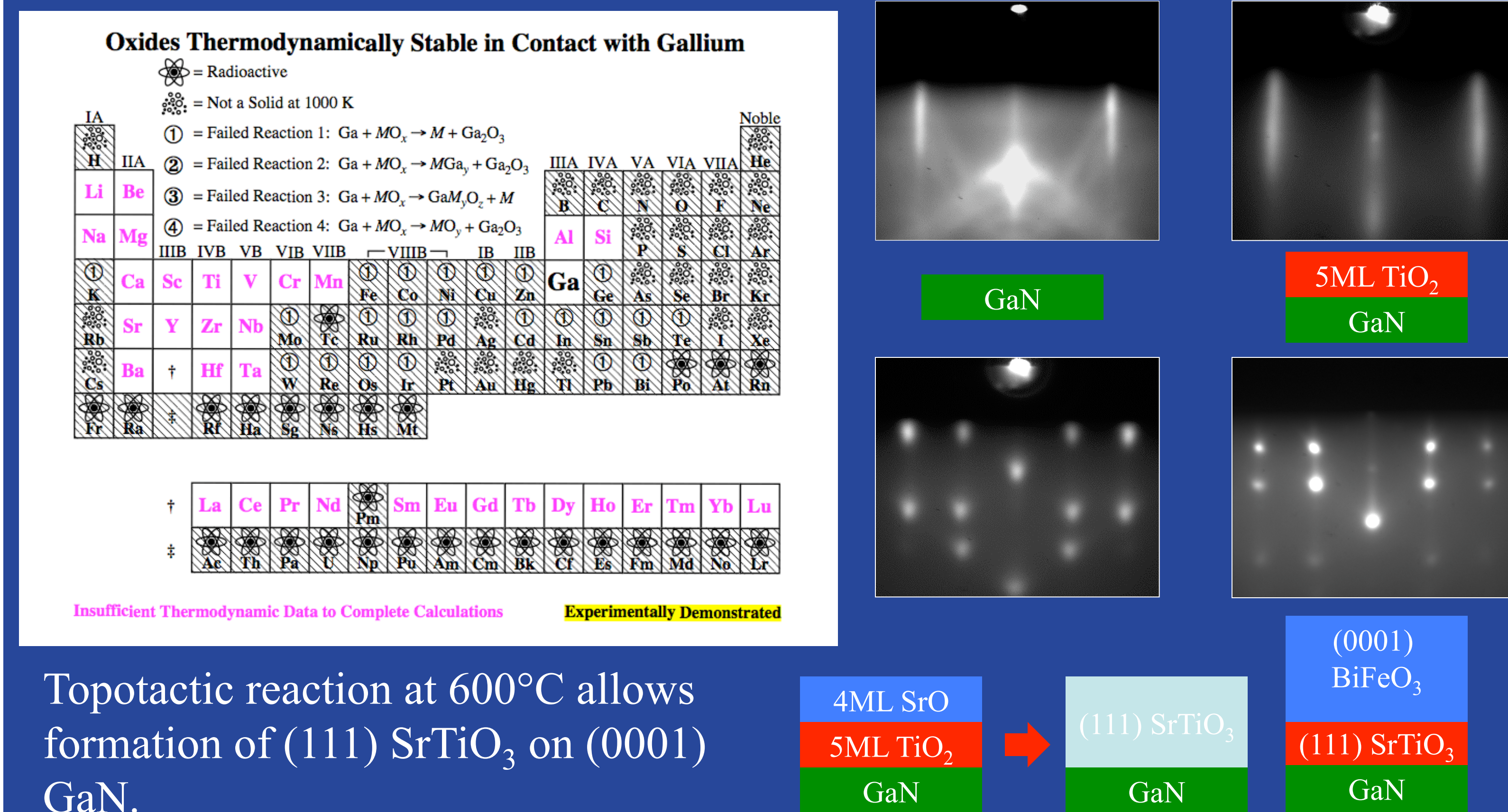
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Introduction

FET devices based wide band-gap semiconductors are desired for applications ranging from communications to power electronics. High-electron mobility transistor (HEMT) structures are particularly interesting owing to the potential for high carrier concentrations in an ‘always-on’ state. A non-volatile means to modulate channel carriers would add an extra dimension to device design. In this work we have investigated methods to integrate BiFeO₃ with GaN to form FE-HEMT devices with particular attention placed on appropriate wide band-gap oxide buffer layers.

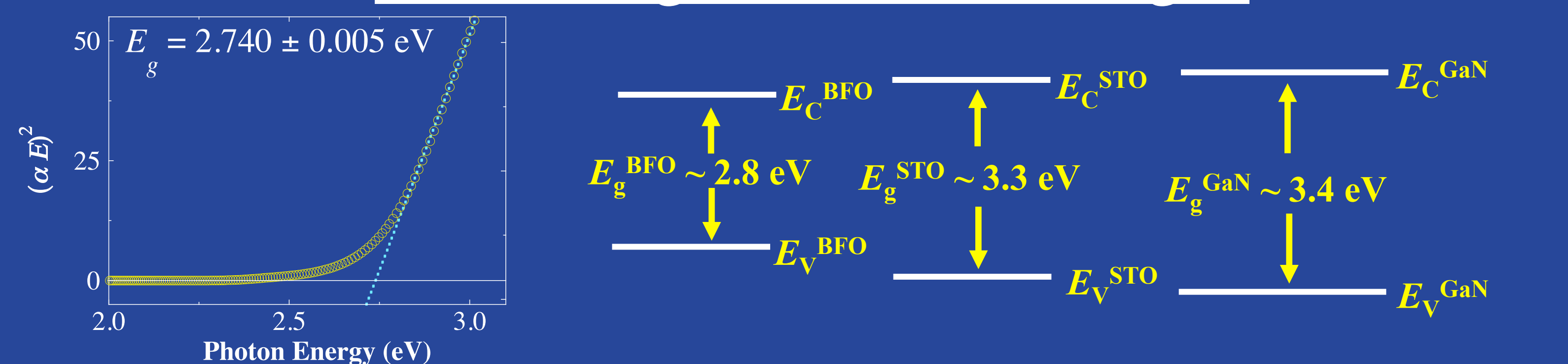


Buffer Layers for Ferroelectric Growth



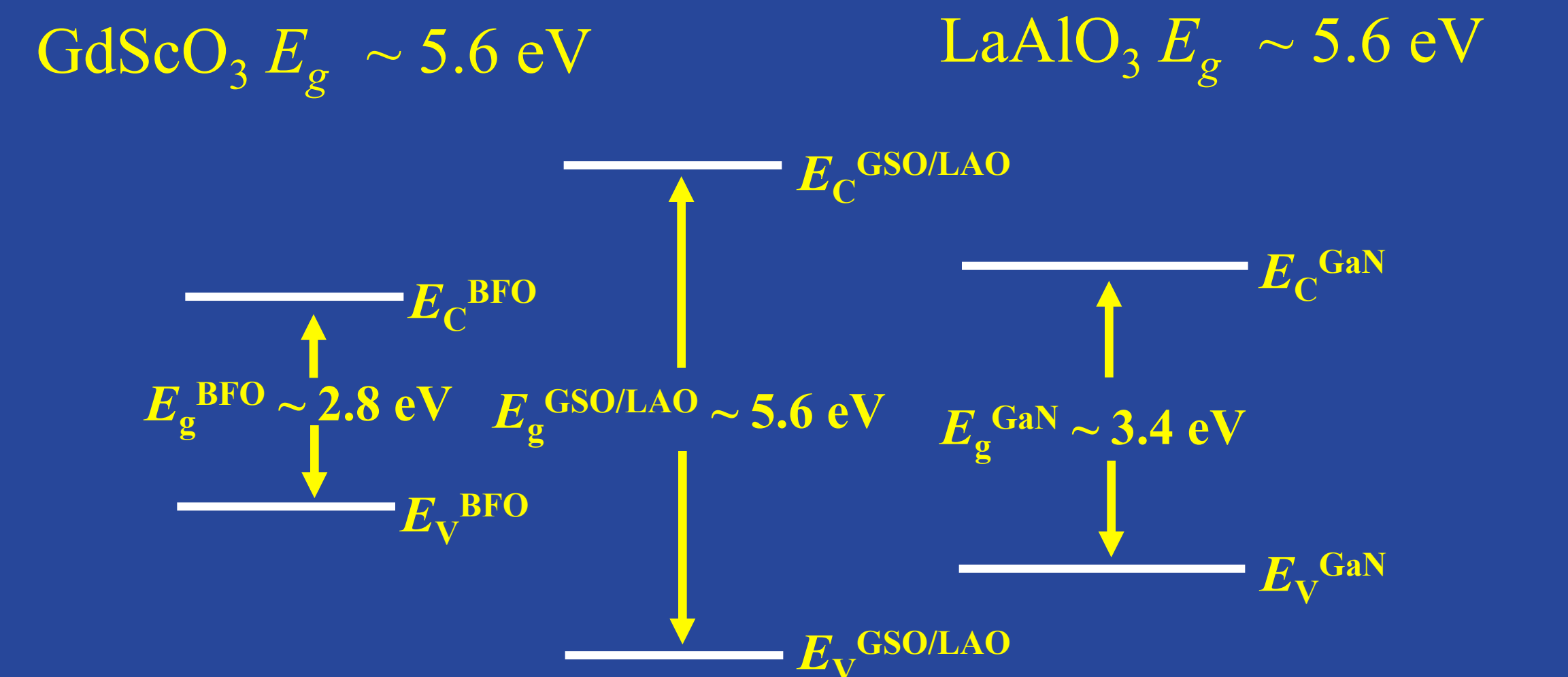
J.F. Ihlefeld, W. Tian, Z.K. Liu, W.A. Doolittle, M. Bernhagen, P. Reiche, R. Uecker, R. Ramesh, and D.G. Schlom "Adsorption-controlled growth of BiFeO₃ by MBE and integration with wide band gap semiconductors" IEEE Trans. On Ultrasonics, Ferroelectrics and Frequency Control, 56(8) (2009)

Band Alignment Challenges

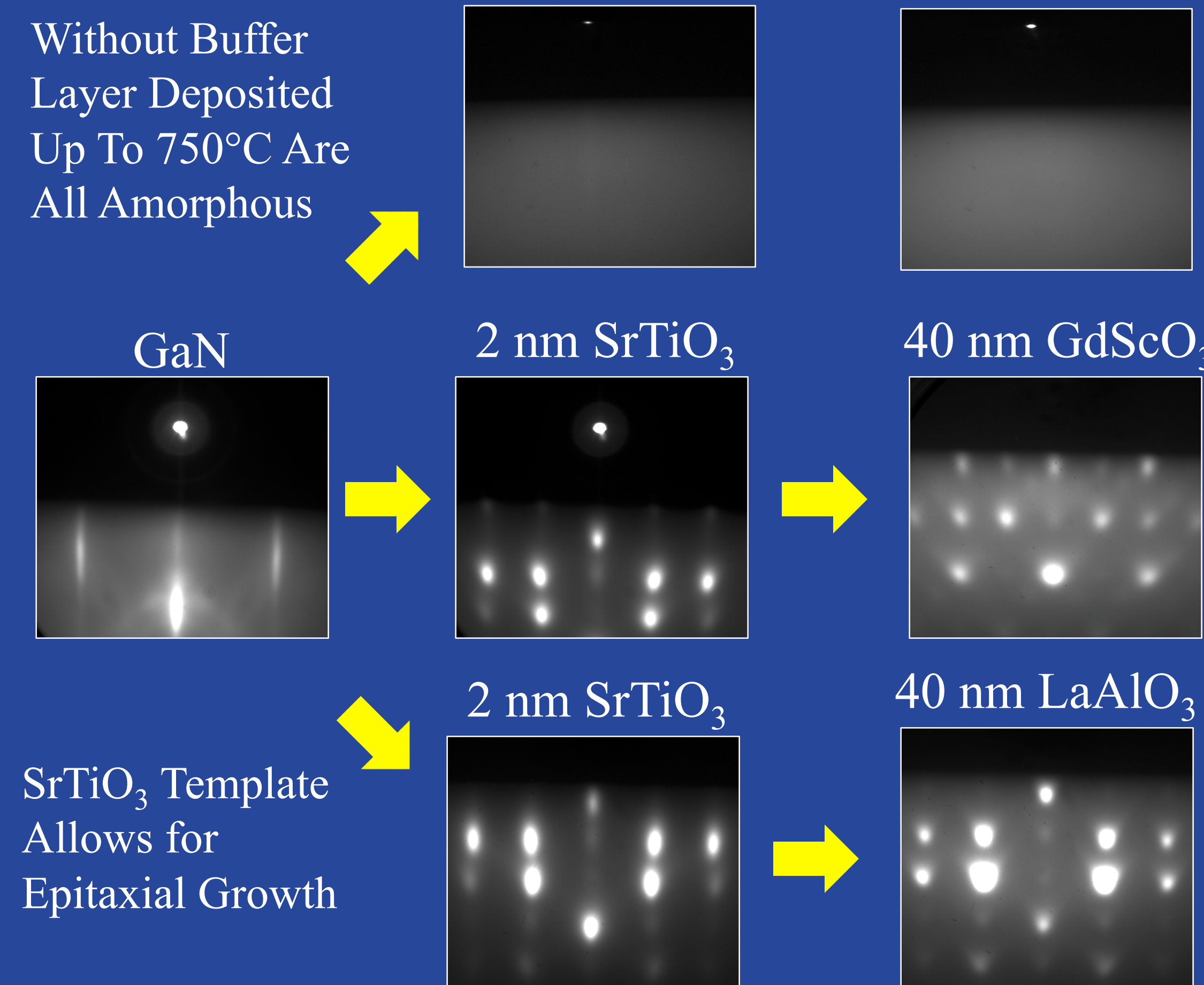


J.F. Ihlefeld, N.J. Podraza, Z.K. Liu, R.C. Rai, X. Xu, T. Heeg, Y.B. Chen, J. Li, R.W. Collins, J.L. Musfeldt, X.Q. Pan, J. Schubert, R. Ramesh, and D.G. Schlom "Optical Band Gap of BiFeO₃ Grown by Molecular-Beam Epitaxy" Applied Physics Letters 92, 142908 (2008)

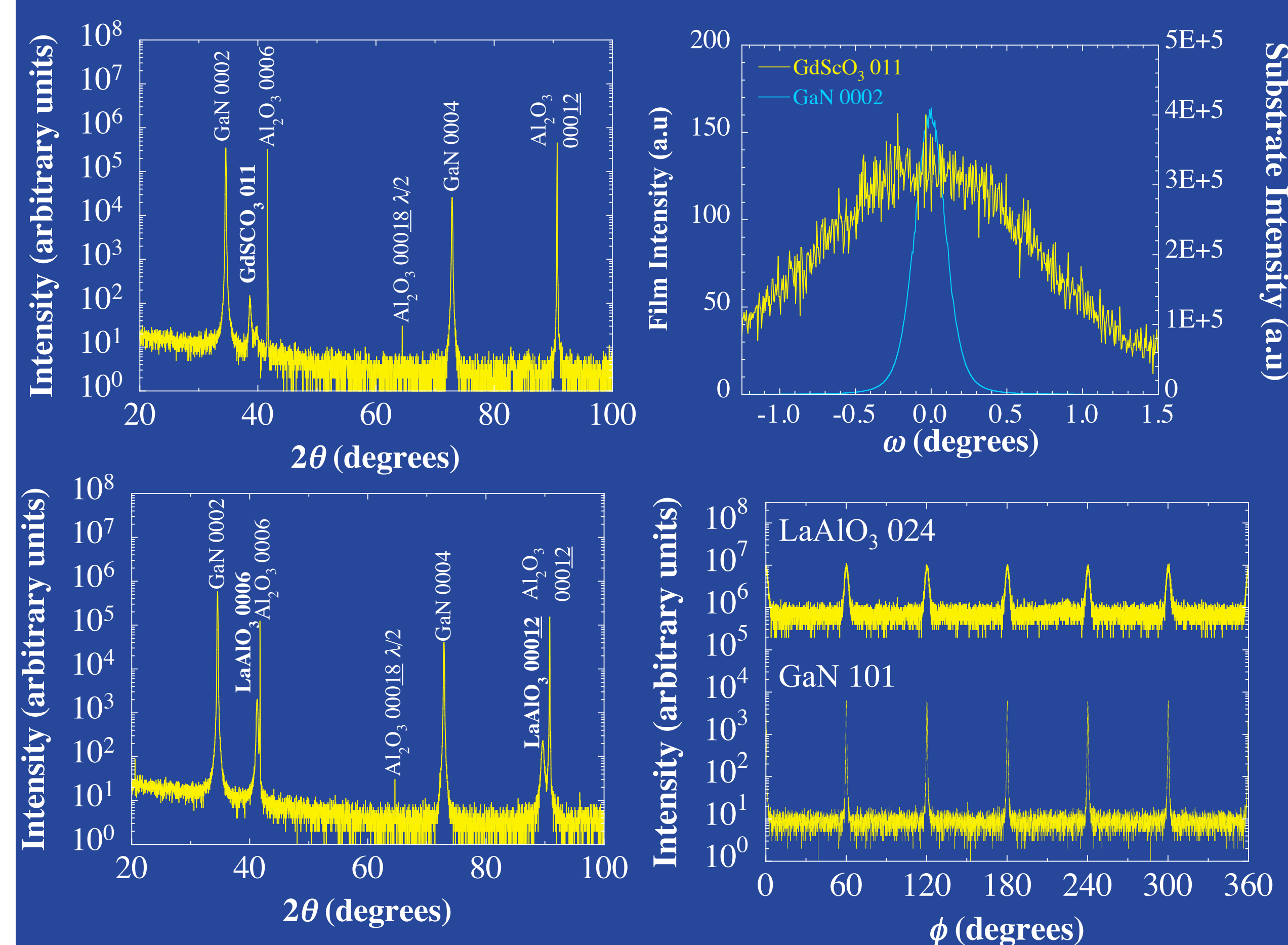
Wide Band-Gap Oxide Integration



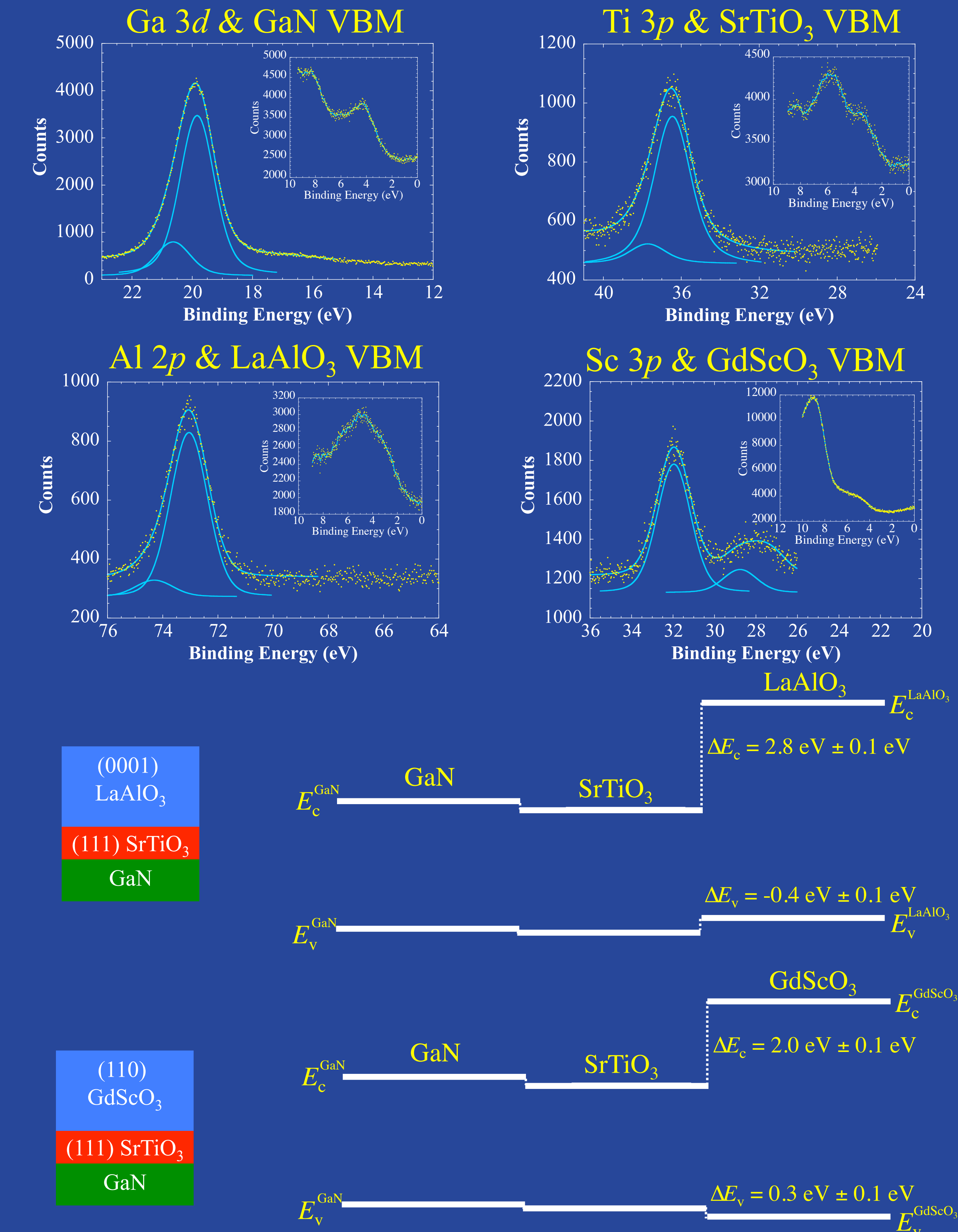
Growth of GdScO₃ and LaAlO₃ on (0001)-GaN



SrTiO₃ Template Allows for Epitaxial Growth

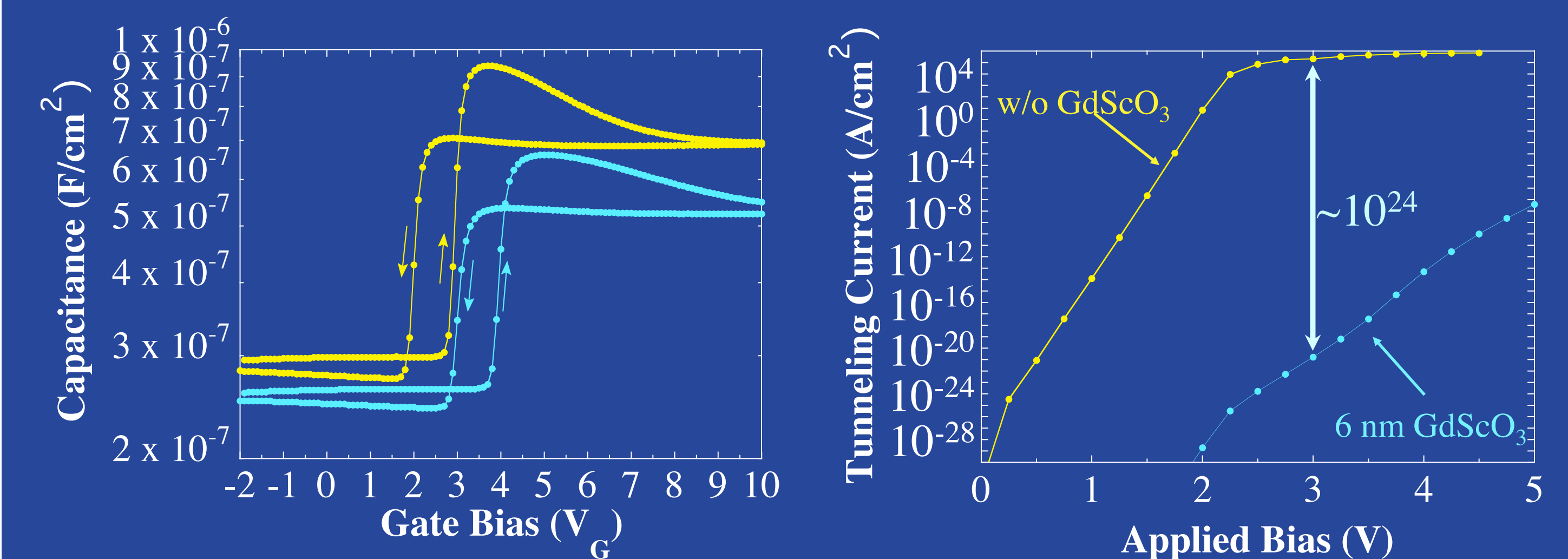


XPS Measured Band Offsets



* Verification of band offsets is currently being performed with high-resolution XPS

BiFeO₃/GdScO₃/SrTiO₃/GaN Devices*



* Data simulated using measured band offsets