Damage-Free Plasma Enhanced Atomic Layer Deposition of AlON Dielectrics on 2D Materials with Tunable Doping

Ardeshir Esteki[1]

Sarah Riazimehr[2], Agata Piacentini[1,3], Harm Knoops[2,4], Martin Otto[3], Gordon Rinke[3], Zhenxing Wang[3], Annika Grundmann[5], Holger Kalisch[5], Michael Heuken[5,6], Andrei Vescan[5], Daniel Neumaier[3,7], Alwin Daus[1,8] and Max C. Lemme[1,3]

[1]Chair of Electronic Devices, RWTH Aachen University, 52074 Aachen, Germany. [2]Oxford Instruments Plasma Technology UK, Bristol BS494AP, United Kingdom. [3]AMO GmbH, Advanced Microelectronic Center Aachen, 52074 Aachen, Germany. [4]Department of Applied Physics, Eindhoven University of Technology, 5600 MB Eindhoven, The Netherland. [5]Compound Semiconductor Technology, RWTH Aachen University, 52074 Aachen, Germany. [6]AIXTRON SE, 52134 Herzogenrath, Germany. [7]Bergische Universität Wuppertal, 42119 Wuppertal, Germany. [8]Sensors Laboratory, Department of Microsystems Engineering, University of Freiburg, 79110 Freiburg, Germany.

Email: max.lemme@eld.rwth-aachen.de / Phone: +49 241 8867 200

In this work, we describe a novel method to deposit high-κ dielectrics on two-dimensional materials (2DMs) through an in situ deposited aluminium oxynitride (AlON) protective layer using an Oxford Instruments Atomfab™ plasma atomic layer deposition (ALD) system. Short, low-power process steps with remote plasma conditions[1] were used to directly grow a thin layer of AlON on commercially available graphene and MoS_2 grown in an Aixtron MOCVD reactor. Statistical Raman spectroscopy data showed no discernible deterioration of the 2DM compared to a standard Al_2O_3 process (Fig. 1c-d). We further validate the 2DM quality with electrical data from field-effect transistors (FETs) encapsulated with AlON (Fig. 1a-b). The current-voltage measurements were performed in a four-point configuration to avoid a strong influence of the contact resistance before and after dielectric deposition under ambient conditions. The AlON dielectric passivation improved the carrier mobilities in the devices (Fig. 1g-h). In addition, the process allows the tuning of the Dirac and threshold voltages proportional to the thickness of the AlON layer (Fig. 1e-f). Our results show that *in-situ* deposited AlON provides a promising route for the encapsulation of 2DM-based electronic devices, as it improves device performance and can be used to tune the Dirac or threshold voltages at the same time.

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References

[1] H. Knoops et al., J. Vac. Sci. Technol. A, 39(6), (2021)

Figures

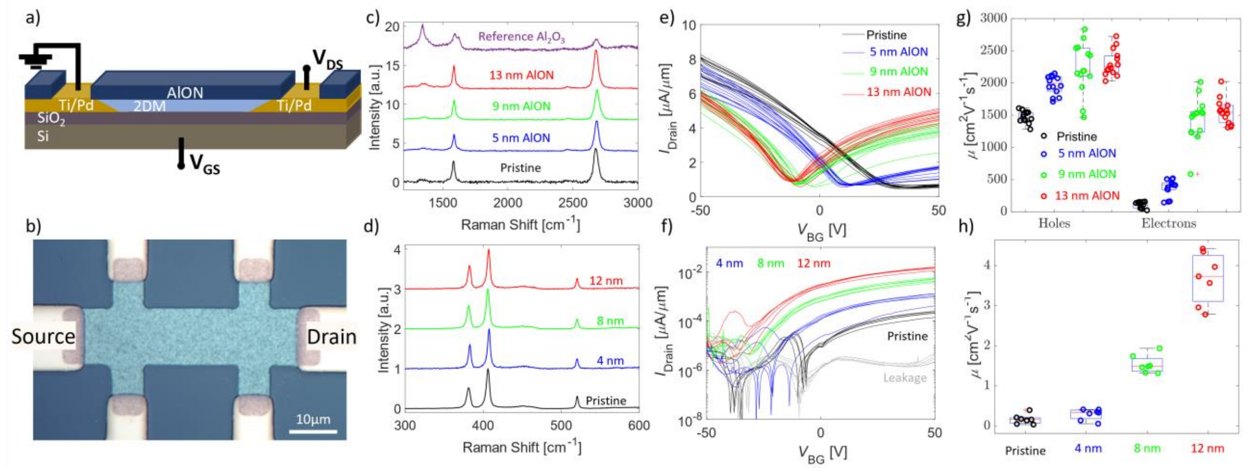

Figure 1: a) Cross-sectional schematic of a back-gated FET with Ti/Pd source and drain bottom contacts and an AlON passivation layer. b) Top-view optical image of the back-gated device. Raman analysis of graphene c) and MoS_2 d) in air and after the deposition of AlON layers with several thicknesses. Current-voltage transfer curves for graphene e) and MoS_2 f). Evaluation of mobilities for graphene g) and MoS_2 h).