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PAPER

Efficient strip to slot waveguide mode converter using fast quasi-adiabatic approach

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Keywords: quasi-adiabatic dynamics, strip to slot converter, adiabatic tapers, silicon photonics

Abstract

We present an ultra-compact strip to slot waveguide mode converter to facilitate excellent fundamental mode coupling between the strip and slot waveguide over a broad wavelength range. The design utilizes tapered waveguide geometries for adiabatic mode conversion. The taper profiles are optimized using a fast quasi-adiabatic approach to achieve the adiabatic mode conversion within the smallest possible length. We numerically demonstrate a conversion efficiency of 99.4% at a wavelength 1.55 μm with a variation of $<$1.5% over a bandwidth of 100 nm and $<$5% over a bandwidth of 200 nm. In addition, the design is ultra-compact with a footprint of only $1.23 \times 3.7\ \mu\text{m}^2$ and offers a high tolerance to the possible fabrication inaccuracies.

1. Introduction

The slot waveguide can confine light within a nanoscale low index gap between two high index strips and hence facilitates strong light–matter interaction. This property of slot waveguide has been utilized in a number of applications including optical modulation [1], all-optical signal processing [2, 3], biosensing [4–6] and absorption-based sensing [7]. The use of polymer filled slot waveguide for modulation and all-optical signal processing allows efficient use of the non-linearity in polymers [1–3]. In biosensing applications, a strong interaction between the waveguide mode and the functionalized waveguide surface of the slot waveguide results in a better sensitivity with smaller device footprint [8, 9]. However, scattering losses associated with slot waveguides are, in general, higher than that of the strip waveguides. Hence, the use of slot waveguides is better suited to the abovementioned applications while for most of the other photonic integrated circuits (PICs), the strip waveguide is a better choice due to its low loss and tight confinement. Also, the efficient designs of grating couplers and edge couplers, to allow coupling of light between the photonic chip and an optical fiber, are available for the strip waveguides [10]. To benefit from the advantages of both the waveguide geometries, there is a need for efficient coupling between the fundamental mode of the strip waveguide and the slot waveguide. Direct butt coupling results in a high loss due to a large mismatch between the fundamental mode of the strip and the slot waveguides and hence a mode converter is needed for efficient coupling of light between these waveguides. Few of the reported designs of the strip to slot waveguide mode converters are solely based on adiabatic mode evolution [11–13]. For adiabatic mode evolution based V-shaped mode converter [11] and ultra-low loss converter [12], the coupling efficiency strongly depends upon the sharpness of the taper tip and hence poses challenges in terms of fabrication. The other design [13] based on adiabatic mode evolution is improved in terms of fabrication tolerance; however, the device footprint can be significantly improved by the appropriate choice of the taper profiles. The other category of strip to slot converter is based on split and combine technique. This technique requires the use of an addition splitter section prior to an adiabatic mode evolution based combiner section [14–17]. The technique utilizes either a y-splitter [14] or a MMI [15–17] to split the light into two strip waveguides followed by a tapered section for adiabatic evolution of the fundamental mode of these

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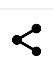
Towards an immersive and safer driving experience using computer vision integrated with encoded vibro-tactile feedback

Rajshekhar Mukherjee, Dharmendra Kumar Mahato, Sangeeta Yadav, Amit Pundir and Geetika Jain Saxena

Published Online: 6 Jul 2020



Abstract

This paper claims to set up an immersive, responsive vehicle driving system and mechanism for an assisted driving technology. The purpose is to expand the sensory horizon of humans while driving and is motivated by absence of any such system in real world. The system can control and direct an assembly of electronic devices in real time, through usage of an image acquisition subsystem, an object-recognition and tracking algorithm and a haptic modelling subsystem working in-tandem with the user. The object tracking subsystem operates in real time to determine the current position of a vehicle in front by using a camera and continuously updates it in a live video feed, while also identifying and tracking the moving or stationary vehicle. The haptic system, which is integrated with the tracking system, has been programmed to warn the driver of the potential threats that moving/stationary vehicles may generate. All the subsystems are updated and synchronised with each other in real-time to produce a seamless and smooth transition between frames, facilitating a precise and immersive driving experience for anyone. The high accuracy and robustness of the proposed system makes it a versatile component, which can be integrated in variety of applications for enhancing a person's reality perception.

Keywords

object tracking, image detection, SURF, vibro-tactile, vision-to-touch, human-centred computing, immersive reality

SILVACO

TCAD Investigation of Total Ionizing Dose (TID) Effects on Gallium Nitride HEMTs

Introduction

Gallium Nitride (GaN) based devices such as the High Electron Mobility Transistors (HEMTs) find wide applications in RF and Power domain due to its excellent intrinsic properties. Accordingly, such devices have also been explored for their radiation hardness which is inherent due to the strong bonding nature of the binary and ternary nitrides. Radiation-induced instabilities including the radiation-induced stress and changes to the material properties leading to the departure of expected results in practical applications.

Due to the limited availability of the test structures and facilities required to analyze the reliability of said devices under ionizing radiations, the cost and time of production gets affected. In this regard, to cut down on the cost and time for production, device engineers require accurate and reliable tools that can accurately predict the robustness of their proposed device architectures in foreign environments. Silvaco's Victory TCAD software is one such tool that can aid the device engineers in this aspect. In this work, we demonstrate the Total Ionizing Dose (TID) Effects on GaN HEMTs using the Radiation Effects Module (REM) available with Silvaco's Victory TCAD suite. In order to make sure that the simulations carried out are in sync with the actual behavior of the device, the simulation deck in Victory Device has been calibrated against the experimental data available from Alvaro et. al.

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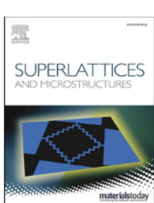

E-mode All-GaN-Integrated cascode MISHEMT with GaN/InAlGaN/GaN backbarrier for high power switching performance: Simulation study

Preeti Singh [a], Vandana Kumari [b], Manoj Saxena [c], Mridula Gupta [a,*]

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ABSTRACT

In this work, simulation-based research work based on a novel All-GaN-Integrated Cascode (AGC) MISHEMT with quaternary layer $In_yAl_xGa_{1-x-y}N$ as backbarrier has been investigated. The AGC-MISHEMT device consists of series combination of enhancement mode (recessed gate MIS-HEMT) and depletion-mode (MIS-gate) GaN devices with GaN/InAlGaN/GaN sandwich back barrier (SW-BB). TCAD simulations indicate that AGC-MISHEMTs with sandwich back barrier (SW-BB) exhibits simultaneous improvement in terms of drain current density (267 mA/mm), high I_{ON}/I_{OFF} ratio (10^8), transconductance-peak (191 mS/mm) and breakdown voltage (371 V) as compared to AGC-MISHEMT with GaN buffer. The impact of varying mole fractions (*x*, *y*), thickness and position of $In_yAl_xGa_{1-x-y}N$ layer on breakdown voltage has also been examined. Improvement in drain current density up to 40% has been accomplished with increased gate oxide thickness under gate 2 (depletion-mode device) for AGC-MISHEMT with SW-BB. Besides, power switching performance has been compared for AGC-MISHEMT with SW-BB to that of AGC-MISHEMT with GaN buffer and Recessed Single Gate (RSG) MISHEMT for inductive load circuit. Significant reduction in power switching losses (i.e. 43% during turn-ON time and 87% during turn-OFF time) has been observed for AGC-MISHEMT with SW-BB as compared to RSG-MISHEMT. In addition, introduction of quaternary InAlGaN layer in backbarrier for AGC-MISHEMT also results in considerable degradation (~89%) in power loss when input gate is in OFF-state due to improved I_{ON}/I_{OFF} ratio in contrast with recessed single gate device.

1. Introduction

The growing demand of highly efficient power conversion systems [1–3] have emphasized the need of highly reliable and efficient power switching transistors with high power handling capability [4]. This leads to requirement of power switching devices with trade-off between ON-resistance and breakdown voltage alongwith low power losses [5]. In this viewpoint, combination of excellent material properties for AlGaN/GaN High-Electron-Mobility-Transistors (HEMTs) such as high carrier mobility, high 2DEG electron concentration and high carrier saturation velocity results in realization of low–ON–resistance of the devices [6,7]. The high critical electric field of GaN based devices also leads to devices with enhanced breakdown voltages [8]. By virtue of these merits, GaN based

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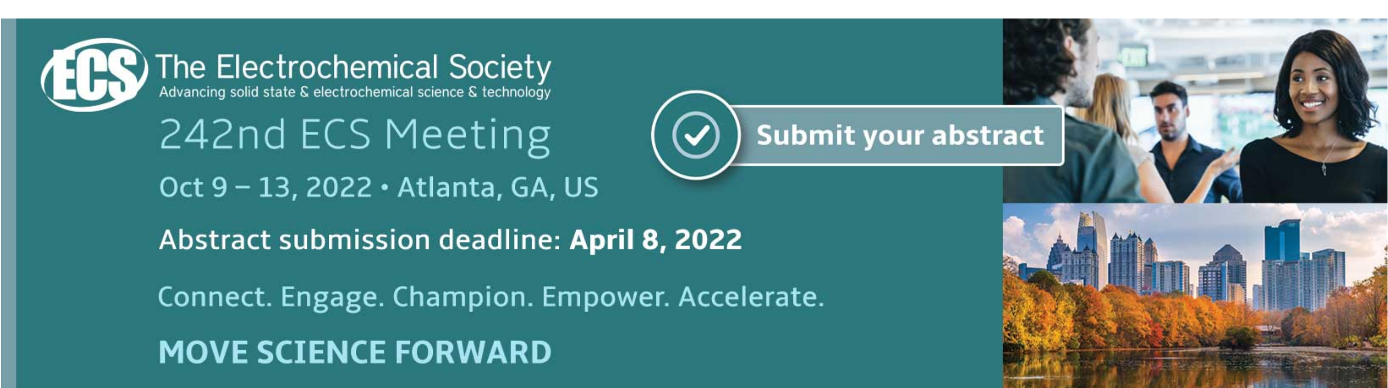

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Vandana Kumari, Mridula Gupta & Manoj Saxena

Published online: 16 May 2021

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Abstract

This paper systematically studies the reliability of non-uniformly doped Double Gate Junctionless transistor using ATLAS TCAD simulation. The reliability analysis is mainly based on the understanding of Band-To-Band-Tunneling (BTBT) current, lattice temperature, drain conductance and gate leakage current. Presented results show that higher source/drain work-function is beneficial in reducing tunneling current (1×10^{-9} A to 4×10^{-11} A @ $V_{gs} = -1$ V) but eventually it will also degrade

electrostatic current significantly (~3 order). Source/Drain length has also been varied during optimization and it has been observed that, shorter source drain

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Vandana Kumari, Manoj Saxena & Mridula Gupta

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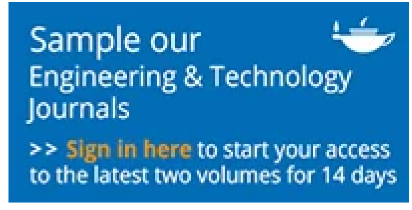

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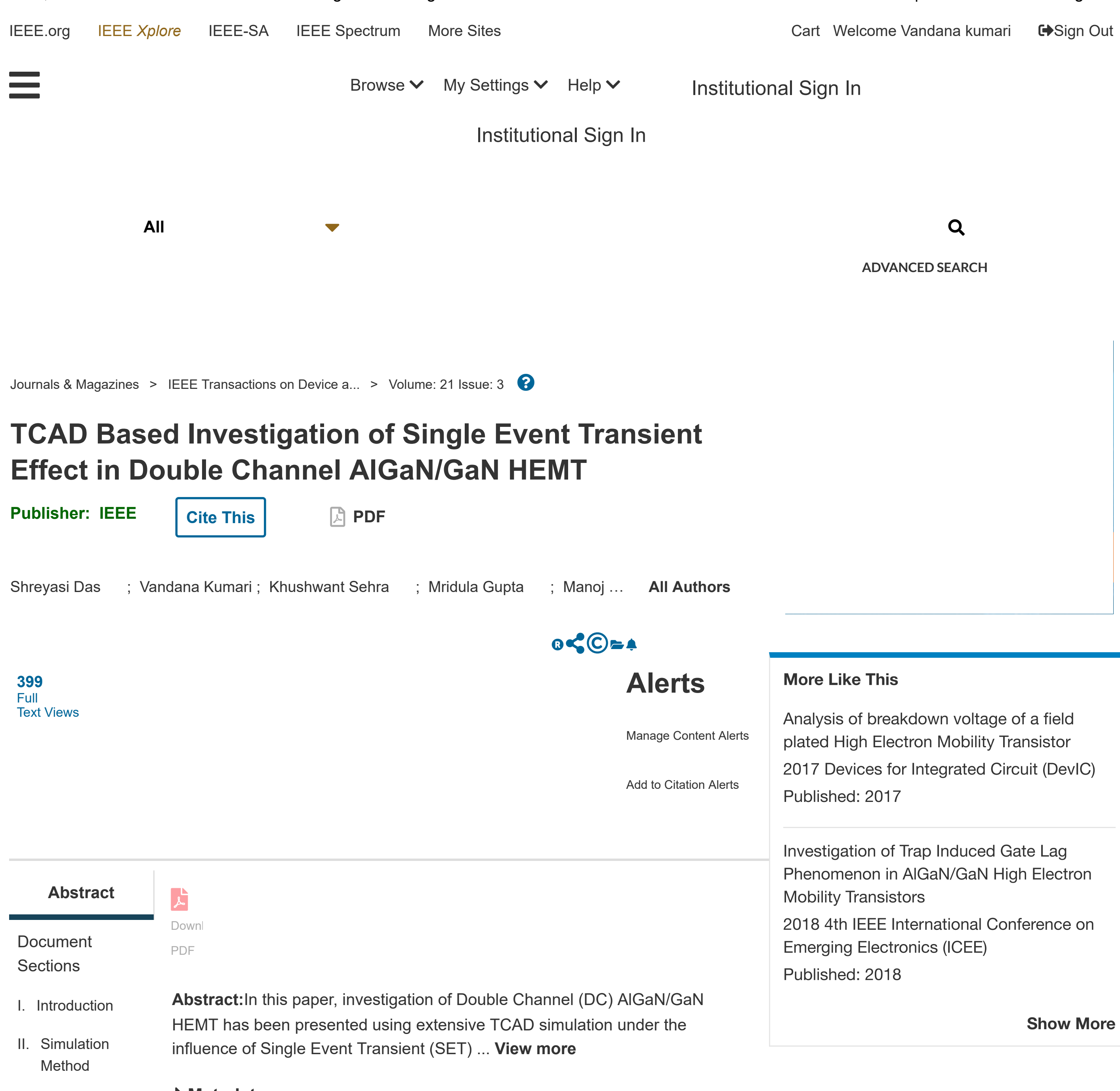
Abstract

TCAD-based numerical investigation of RingFET has been presented in this paper for the detection of gas molecules. Sensitivity of the device has been assessed by calculating the change in off-state current with the change in gate work-function (which changes due to the presence of gas molecule). The behavior of the device has also been compared with the equivalent bulk MOSFET and it was observed that RingFET architecture shows 23% higher sensitivity against gas molecules than

equivalent bulk MOSFET. Also, the degradation in device sensitivity with applied drain bias is higher in bulk MOSFET. Optimization in the sensitivity parameter has



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Preeti Singh, Vandana Kumari, Manoj Saxena & Mridula Gupta

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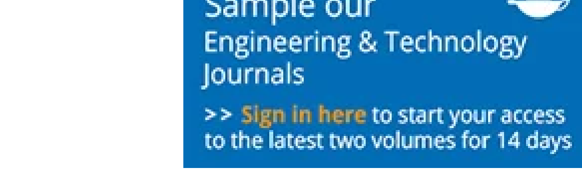

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Abstract

This investigation examines the performance of AlGaN/GaN MISHEMTs having single-gate and dual-gate with different biasing combinations to explore the linearity in terms of g_{mpeak}, gate voltage swing (GVS) and higher-order coefficients for intermodulation distortion for low-noise amplifiers (LNAs). In addition, the influence of distinct gate biasing configurations of DG-MISHEMT on current collapse (CC) (in response to OFF-state stress in drain) has been studied using TCAD

simulations. It has been observed that drop in drain current value after the gate–drain voltages return to quiescent voltages (V_{GSQ}, V_{DSQ}) reduces for DG-MISHEMT

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Preeti Singh, Vandana Kumari, Manoj Saxena & Mridula Gupta

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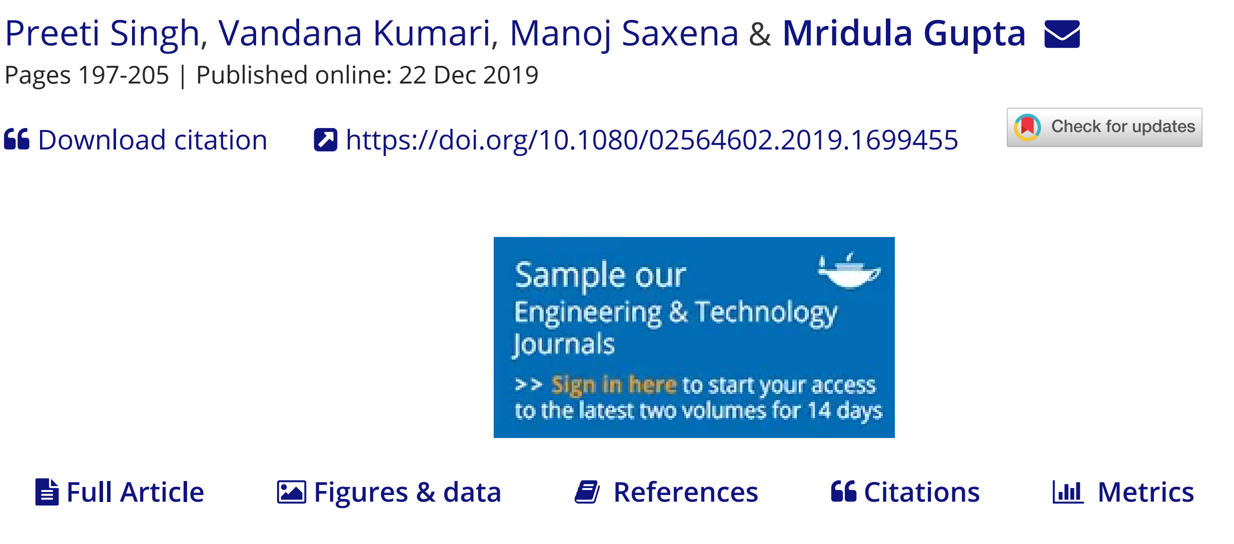

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ABSTRACT

This paper examines the DC performance of Dual-Gate MISHEMT with different substrate material such as sapphire, silicon carbide SiC, and silicon. The performance parameters evaluated are threshold voltage, drain current, transconductance, and drain conductance. It is observed that DG-MISHEMT with the sapphire substrate and HfO_2 gate dielectric results in positive threshold voltage shift from −4.7 to −3.8 V(∼19%) and also degrades the drain current as compared to

the device with silicon nitride gate dielectric due to the reduced channel charge concentration. But the device with HfO_2/Al_2O_3 gate stack maintains 182 mA/mm of

TCAD-Based Investigation of Double ... 1 / 7 100%

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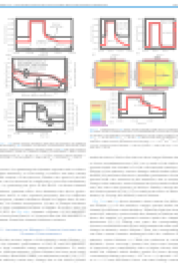

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Performance evaluation of dielectric modulation and metalloid T-shaped source/drain on gate-all-around junctionless transistor for improved analog/RF application

Yogesh Pratap[1,*], Sachin Kumar[2], R. S. Gupta[3], and Mridula Gupta[4]

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ABSTRACT

In this work, the impact of SiO_2 dielectric channel modulation along with metalloid T-shaped source-drain on the analog-RF characteristics of gate-all-around Junctionless Nanowire Transistor (JNT) has been analysed. Metalloid T-shaped source-drain contacts create the charge plasma therefore it is also referred as Charge Plasma Transistor (CPT). Impact of different source/drain materials on band gap energy, drain current, transconductance etc. is studied. Ambipolarity, Non-linear behavior and impact of high temperature on novel CPT-JNT device have also been analysed. A dielectric modulated CPT-JNT is proposed. Results demonstrate that charge plasma technique resolve the degeneracy problem of semiconductor in junctionless transistor. Use of dielectric pocket completely reduces the ambipolar nature of CPT-JNT. Use of Charge plasma technique along with gate-all-around junctionless transistor tremendously increases transconductance, device gain (current and power). The device is well suitable for analog/RF applications.

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