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Influence of Series Resistance and Interface State Density on Electrical Characteristics of Ru/Ni/n-GaN Schottky structure

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Abstract—**We have investigated the electrical properties of Ru/Ni/n-GaN Schottky structure using current-voltage (I-V) and capacitance-voltage (C-V) measurements at room temperature. The barrier height (Φ_{bo}) and ideality factor (n) of Ru/Ni/n-GaN Schottky structure are found to be 0.66 eV and 1.44, respectively. The Φ_{bo} and the series resistance (R_S) obtained from Cheung's method are compared with modified Norde's method, and it is seen that there is a good agreement with each other. The energy distribution of interface state density (N_{SS}) is determined from the I-V measurements by taking into account the bias dependence of the effective barrier height. Further, the interface state density N_{SS} as determined by Terman's method is found to be 2.14×10^{12} cm^{-2} eV^{-1} for the Ru/Ni/n-GaN diode. Results show that the interface state density and series resistance has a significant effect on the electrical characteristics of studied diode.**

Index Terms—**Ru/Ni/n-GaN, series resistance, interface state density, Terman's method**

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I. INTRODUCTION

Wide bandgap materials like gallium nitride (GaN) have been extensively used in optoelectronic devices such as light emitting diodes, laser diodes and UV detectors [1, 2]. This is due to their many good properties like the efficient, long-lasting light-emitting capability, especially in the visible range, the chemical stability, the mechanical strength and high temperature endurance. Due to the technological importance of metal-semiconductor (MS) structures, a full understanding of the surface and interface properties of Schottky barrier diodes is of great interest. It is clear that the deviations from the ideal Schottky barrier formation are localized within a few atomic layers of the MS intimate contact with energies which fall inside the forbidden gap. Such charge accumulated at the MS contact reduces the effective potential difference between the semiconductor and the metal contact [3]. The MS contact is one of the most widely used rectifying contacts in device technology [4, 5]. It is well known that Schottky barrier diode (SBD) possesses a thin interfacial native oxide layer between the metal and the semiconductor. The existence of such an insulating layer can have a strong influence on the diode characteristics as well as the interface state density (N_{SS}), ideality factor (n) and barrier height (Φ_{bo}). The interface states play an important role on determination of Φ_{bo} and other characteristic parameters, and these can affect the device performance, stability and reliability. In this work, Nickel

(Ni) has been selected as the first layer because it has high work function metal 5.15 eV as well as good adhesion and reactivity with GaN. Ruthenium (Ru) is selected as second layer since it has high melting point, hence Schottky contacts with Ru/Ni metal alloy can operate with stability at high temperature and in high power systems.

II. EXPERIMENTAL TECHNIQUE

In this work, 2 μm-thick Si-doped N-face GaN wafer used was grown by metal organic chemical vapor deposition (MOCVD) on the c-plane Al_2O_3 sapphire substrate. The carrier concentration obtained by means of Hall measurements is ~ 4.07×10^{17} cm^{-3}. Prior to the metal deposition, the n-type GaN wafer was first ultrasonically degreased with warm trichloroethylene, acetone and methanol for 5 min each step, followed by rinsing in deionized (DI) water. The degreased wafer was then dipped into boiling aquarezia [HNO_3:HCl=1:3] for 10 min to remove the native oxides. For ohmic contacts, bilayer of Ti (25 nm)/Al (100 nm) were deposited on a portion of the wafer and then annealed at 650°C for 3 min in N_2 ambient. Ru (30 nm)/Ni (20 nm) Schottky contacts with a diameter of 0.7 mm were deposited on n-GaN surface using an electron beam evaporation system under a pressure of 5×10^{-6} mbar. The current-voltage (I-V) and capacitance-voltage (C-V) characteristics of Ru/Ni/n-GaN Schottky diode were measured using a Keithley source measurement unit 2400 and automated DLTS (DLS-83D) system at room temperature.

III. RESULTS AND DISCUSSION

The typical forward and reverse bias I-V characteristics of Ru/Ni/n-GaN SBD are measured at room temperature and shown in Fig. 1. The forward I-V characteristics of the Schottky diode can be described by the following equation [5]

$$I = AA^*T^2 \exp\left(-\frac{q\Phi_{bo}}{kT}\right)\exp\left[\left(\frac{qV}{nkT}\right)-1\right] \quad (1)$$

When V>3nkT/q, the equation is transformed as following manner

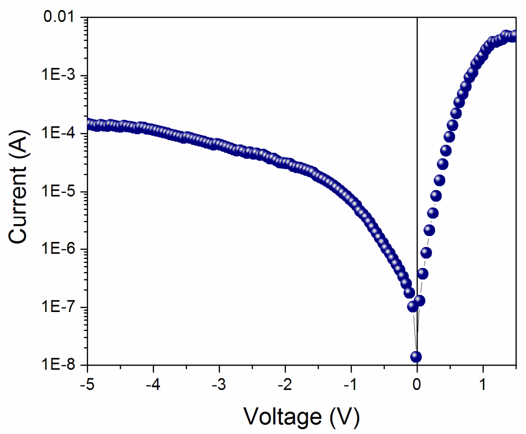

Fig. 1. Typical current-voltage characteristics of the Ru/Ni/n-GaN Schottky diode at room temperature.

$$I = AA^*T^2 \exp\left(-\frac{q\Phi_{bo}}{kT}\right)\exp\left(\frac{qV}{nkT}\right) \quad (2)$$

In forward direction, the equation could also be expressed as

$$\ln I = \frac{q}{nkT}V + \left(\ln AA^*T^2 - \frac{q\Phi_{bo}}{kT}\right) \quad (3)$$

where q is the electron charge, V is the applied voltage, T is the absolute temperature, n is the ideality factor, k is the Boltzmann's constant, A is contact area and A^* is the effective Richardson constant assumed to be 26.4 A/(cm K)^2 for n-GaN [6]. The Φ_{bo} and n of Ru/Ni/n-GaN Schottky diode are calculated using Eq. (3). The slope of straight line region of the forward-bias I-V characteristics (ln I versus V) through the relation

$$\Phi_{bo} = intercept.\ (kT/q) \quad (4)$$

And

$$n = \frac{q}{kT}.\frac{1}{slope} \quad (5)$$

where n is a measure of conformity of the diode to pure thermionic emission (TE). As shown in Fig. 1, the I-V characteristics of the Ru/Ni/n-GaN Schottky diode exhibits an excellent rectifying behavior with relatively low leakage current of 7.47 μA at a reverse bias of -1 V. The forward bias I-V curve quickly becomes dominated by series resistance (R_S) from contact wires or bulk resistance of the semiconductor, giving rise to the curvature at high voltage region. Calculations showed that the Φ_{bo} and n values of the Ru/Ni/n-GaN Schottky diode are 0.66 eV and 1.48 respectively. The Ru/Ni/n-GaN Schottky diode with a large value of ideality factor is distant from ideal due to the presence of a thin interfacial layer (IL) and the interface states. The non-linearity of I-V characteristics at high bias values confirmed a continuum of interface states, which is in equilibrium with the semiconductor [7].

As can be seen from Fig. 1, the forward bias I-V characteristics are linear on a semi-log scale at low forward bias voltages, but deviate considerably from linearity due to the effect of R_S, the IL and the interface states when the applied voltage is adequately large. According to Cheung [8] method, the values of Φ_{bo} and R_S can be evaluated using a technique in the high bias voltage where the ln I-V curves does not show linear behavior as follows:

$$\frac{dV}{d(\ln I)} = n\left(\frac{kT}{q}\right) + R_S I \quad (6a)$$

$$H(I) = V - \frac{nkT}{q}\ln\left(\frac{I}{AA^*T^2}\right) \quad (6b)$$

and

$$H(I) = n\Phi_{bo} + R_S I \quad (6c)$$

Fig. 2 shows the experimental dV/d(lnI) versus I and H(I) versus I plots for the Ru/Ni/n-GaN Schottky diode at room temperature. Eq. (6a) gives a straight line for the data of downward curvature region in the forward bias I-V characteristics. Thus, the values n and R_S are derived from the intercept and slope of dV/d(lnI) versus I plot, and the corresponding values are 1.48 and 445 Ω. A plot of H(I) versus I (Fig. 2) will also lead to a straight line with the y-axis intercept equal to $n\Phi_{bo}$, substituting using the n value resultant from Eq. (6a) and the data of the downward curvature region in the forward bias I-V characteristics in Eq. (6c), and obtained Φ_{bo}. The slope of this plot also determines R_S, which can be used to check the consistency of Cheung's approach. From H(I) versus I, the Φ_{bo} and R_S values are found to be 0.67 eV and 685 Ω, respectively. Moreover, the values of R_S obtained from dV/d(lnI) versus I and H(I) versus I plots are in good agreement with each other. This case shows the technical consistency of Cheung's approach.

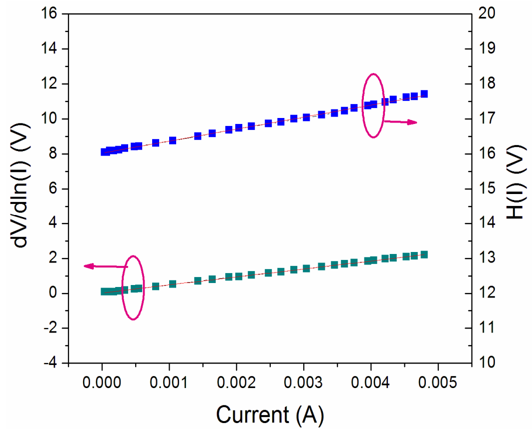

Fig. 2. Cheung's plots of series resistance of the Ru/Ni/n-GaN Schottky diode at room temperature.

Because high series resistance can hinder an accurate evolution of barrier heights from the standard I-V plot, the Norde method was also employed [9] to compare the effective Schottky barrier heights (SBHs) of the Ru/Ni/n-GaN Schottky diode. The modified Norde's function is as follows

$$F(V) = \frac{V}{\gamma} - \left(\frac{kT}{q}\right)\ln\left[\frac{I(V)}{AA^*T^2}\right] \quad (7)$$

where γ is the integer (dimensionless) greater than n. I(V) is the current obtained from the forward bias I-V curve. The effective barrier height Φ_{bo} is given as

$$\Phi_{bo} = F(V_{\min}) + \frac{V_{\min}}{\gamma} - \frac{kT}{q} \quad (8)$$

where $F(V_{min})$ is the minimum point of F(V) and Vmin is the corresponding voltage. A plot of the Norde function F (V) versus V for the Ru/Ni/n-GaN Schottky diode is shown in Fig. 3. The value of R_S is also obtained as follows

$$R_S = \frac{kT(\gamma - n)}{qI} \quad (9)$$

Using Eqs. (8) and (9), the Φ_{bo} and the R_S values for the diodes are found to be 0.69 eV and 561 Ω, respectively. The R_S causes a non-linear region of I-V curve of the diode. There is a good agreement among the

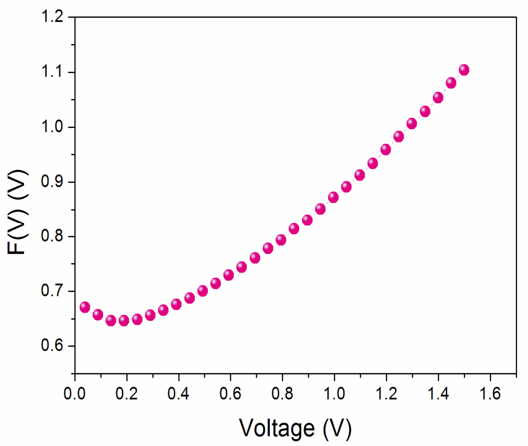

Fig. 3. F(V) versus V plot of Ru/Ni/n-GaN Schottky diode at room temperature.

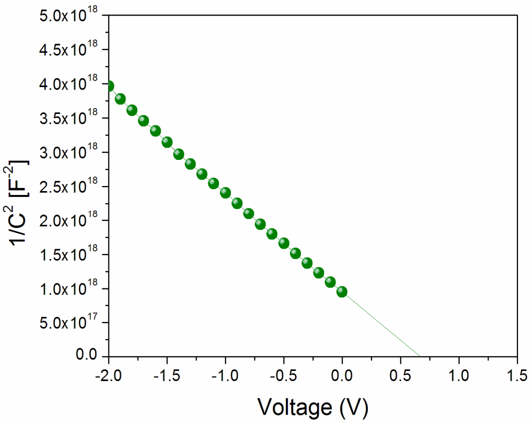

Fig. 4. The reverse bias $1/C^2$ versus V characteristics of the Ru/Ni/n-GaN Schottky diode at room temperature.

values of Φ_{bo} obtained from the forward bias ln I-V, Cheung's method and Norde's methods. Also, it is noted that the R_S value obtained from Norde's method is in good agreement with those obtained from the Cheung's method. Furthermore, the values of R_S indicated that the R_S is a current-limiting factor for this structure. The effect of the R_S is usually modeled with series combination of a diode and a resistance. The voltage drop across a diode is determined in terms of the total voltage drop across the diode and the resistance.

The capacitance-voltage (C-V) relationship for Schottky contact is given by [4]

$$\frac{1}{C^2} = \frac{2\left(V_{bi} - \frac{kT}{q} - V\right)}{A^2 q N_d \varepsilon_s} \tag{10}$$

where ε_S is the permittivity of the semiconductor, V is the applied voltage and A is the contact area of the diode. The x-intercept of the plot of $(1/C^2)$ versus V is V_o and related to built-in potential V_{bi} by the equation $V_{bi}=V_o+kT/q$, where T is the absolute temperature. The barrier height is given by $\Phi_b=V_{bi}+V_n$, where $V_n=(kT/q)$ ln (N_c/N_d). The density of states in the conduction band edge is given by $N_c=2(2\pi m^*kT/h^2)^{3/2}$, where $m^*=0.22m_o$, and its value was 2.6×10^{18} cm^{-3} for GaN at room temperature. Fig. 4 shows a plot of $1/C^2$ as a function of bias voltage V at frequency of 1 MHz for Ru/Ni/n-GaN Schottky diode. From the slope of the graph the carrier concentration (N_d) is calculated as 9.9×10^{17} cm^{-3} for as-deposited contact. This value is used for the calculation of barrier height. In C-V measurements, the net doping concentration is difference of the electrically active concentration of donors and acceptors. In case of n-type material, the concentration of donors outbalances the concentration of acceptors. One more reason, the decrease in barrier height with increasing dopant concentration is due to the effect of the interfacial layer and interfaces states [10]. The calculated barrier height of Ru/Ni/n-GaN Schottky diode is 0.79 eV by C-V method.

Typically, a thin IL is always present due to incomplete covalent bonds, chemical reaction and sharp discontinuity between MS contact [11], which results in a new dielectric phase. The existence of an electric charge in the thin IL, which is neither semiconductor nor metal, introduces a high density of interface states [12]. When a MS contact with an IL is considered, it is assumed that the forward bias current in a Schottky barrier is due to TE current corrected by tunneling, which is represented [7] as

$$I = AA^* \exp\left(-\chi^{0.5}\delta\right)\left(-\frac{q\Phi_{bo}}{kT}\right)\exp\left(\frac{qV}{nkT}\right) \tag{11}$$

where χ is the mean barrier height presented by the thin IL of thickness (δ). The term $\exp(-\chi^{0.5}\delta)$ is commonly known as the transmission coefficient across the thin IL. The values of n and Φ_e are assumed to be voltage dependent and can be written following equations, respectively [7, 13]

$$n(V) = \frac{q}{kT}\left[\frac{(V - IR_S)}{\ln\left(\frac{I}{I_o}\right)}\right] = 1 + \frac{\delta}{\varepsilon_i}\left[\frac{\varepsilon_S}{W_D} + qN_{SS}(V)\right] \tag{12}$$

$$\Phi_e = \Phi_{bo} + \beta(V - IR_S) = \Phi_{bo} + \left(1 - \frac{1}{n(V)}\right)(V - IR_S) \tag{13}$$

where β is the voltage coefficient of Φ_e, W_D is the space-charge region width being deduced from the experimental C-V measurements at high-frequency (1 MHz), N_{SS} is the density of the interface states and ε_S and ε_i are permittivities of the semiconductor and the IL, respectively. The expression for the N_{SS} can be given as

$$N_{SS} = \frac{1}{q}\left[\frac{\varepsilon_i}{\delta}\left(n(V) - 1\right) - \frac{\varepsilon_S}{W_D}\right] \tag{14}$$

The interface state energy distribution and relative IL thickness is determined by Card and Rhoderick [7], and Kolnik and Ozvold [14]. In the case where the entire interface states are in equilibrium with the semiconductor when the diode is forward biased, whereas in the reverse direction the change of the interface state charge is negligible. The IL thickness has been estimated from I-V and C-V measurements [15-18]. We have evaluated the value of δ/ε_i from the following expression [14, 19].

$$\frac{\delta}{\varepsilon_i} = \left[\frac{\varepsilon_S}{W_D}\left(\frac{1}{\beta_r} - 1\right)\right]^{-1} \tag{15}$$

where β_r=(kT/q)(d(lnI)/dV) is the slope of the I-V characteristics. In an n-type semiconductor, the energy of the interface states with respect to the bottom of the conduction band at the surface of the semiconductor is given by [7, 20, 21]

$$E_C - E_{SS} = q(\Phi_e - V) \tag{16}$$

By using Eqs. (12)-(16), the I-V characteristics can be used for the evaluation of the N_{SS} as a function of interface states energy E_{SS}. N_{SS} versus E_C-E_{SS} is shown in Fig. 5. Substituting the values of the n(V) in Eq. (12) using δ=9.72 Å and W_D=1.42 μm, the N_{SS} as evaluated by Terman's method is found to be 2.14×10^{12} cm^{-2} eV^{-1}

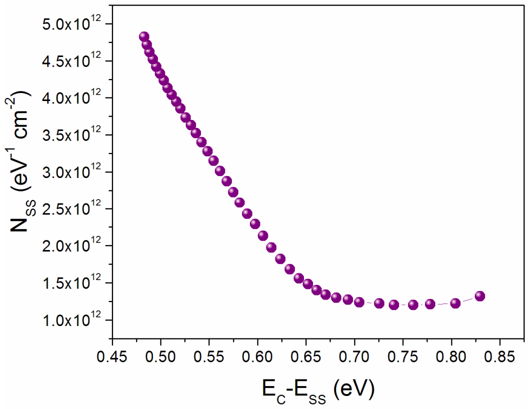

Fig. 5. Interface state density distribution profiles as a function of E_C-E_{SS} for Ru/Ni/n-GaN Schottky diode at room temperature.

for the Ru/Ni/n-GaN Schottky diode [22]. From Fig. 5, it can be seen that an exponential increase in interface states density exists from mid gap towards the bottom of the conduction band.

IV. CONCLUSIONS

In this work, the interface properties of Ru/Ni/n-GaN Schottky diode have been investigated by current-voltage (I-V) and capacitance-voltage (C-V) measurements. The value of the R_S is calculated from high voltage region of the structure by Cheung's method. It is noted that there is a good agreement between the values of the R_S obtained from Cheung's and modified Norde's method. Further, the N_{SS} calculated by Terman's method is 2.14×10^{12} cm^{-2} eV^{-1} for the Ru/Ni/n-GaN Schottky diode. It is clear that ignoring the role of interfacial insulator layer, N_{SS} and R_S can lead to significant errors in the electrical characteristics of devices.

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REFERENCES

[1] S. Nakamura, M. Senoh, S. Nagahama, N. Iwasa, T. Yamada, T. Matsushita, H. Kiyoku, and Y. Sugimoto, "InGaN-based multi-quantum-well structure laser diodes," *Jpn. J. Appl. Phys.*, vol. 35, pp. L74-L76, 1996.

[2] S. Nakamura, M. Senoh, S. Nagahama, N. Iwasa, T. Yamda, T. Matsushita, H. Kiyoku, Y. Sugimoto, T. Kozaki, H. Umemoto, M. Sano, and K. Chocho, "Continuous-wave operation of InGaN/GaN/ AlGaN-based laser diodes grown on GaN substrates," *Appl. Phys. Lett.*, vol. 82, no. 16, pp. 2014-2016, 2003.

[3] J. Bardeen, " Surface states and rectification at a metal semiconductor contact," *Phys. Rev.*, vol. 71, no. 10, pp. 717-727, 1947.

[4] S. M. Sze, "Physics of Semiconductor Devices," Wiley & Son, 1981.

[5] E. H. Rhoderick, and R. H. Williams, "Metal-Semiconductor Contacts," Clarendon Press, Oxford, 1988.

[6] M. Drechsler, D. M. Hofmann, B. K. Meyer, T. Detchprohm, H. Amano, and I. Akasaki, "Determination of the conduction band electron effective mass in hexagonal GaN," *Jpn.J. Appl. Phys*., vol. 34, no. 9B, pp. L1178-L1179, 1995.

[7] H. C. Card, and E. H. Rhoderick, "Studies of tunnel MOS diodes I. interface effect in silicon Schottky diodes," *J. Phys. D: Appl. Phys.*, vol. 4, no. 10, pp. 1589-1601, 1971.

[8] S. K. Cheung, and N. W. Cheung, "Extraction of Schottky diode parameters from forward current-voltage characteristics," *Appl. Phys. Lett.*, vol. 49, no. 2, pp. 85-87, 1986.

[9] H. Norde, "A modified forward I-V plot for Schottky diode with high series resistance," *J. Appl. Phys.*, vol. 50, no. 7, pp. 5052-5053, 1979.

[10] Zs. J. Horvath, I.Gyuro, M.N. Sallay, and P. Tutto, "Near-interface concentration reduction in n-type Au/Cr GaAs Schottky contacts," *Vacuum*, vol. 40, no. 1-2. pp. 201-203, 1990.

[11] B.G. Streetman, and S.K. Banerjee, "Solid state electronic devices," Prentice-Hall, Englewood, NJ, 2006.

[12] A. Geozberger, V. Heine, and E.H. Nicollian, "Surfaces states in silicon from charges in the oxide coating," *Appl. Phys. Lett.*, vol. 12, no. 3, pp. 95-98,1968.

[13] H. Kanbur, S. Altindal, and A. Tataroglu, "The effect of interface states, excess capacitance and series resistance in the Al/SiO_2/p-Si Schottky diodes," *Appl. Surf. Sci.*, vol. 252, no. 5, pp. 1732-1738, 2005.

[14] J. Kolnik, and M. Ozvold, "The influence of insertion surface layers on the evaluation of the interface state energy distribution from Schottky diode I-V characteristics," *Phys. Stat. Sol. (a)*,vol. 122, no.2, pp. 583-588, 1990.

[15] S. J. Fonash, "A reevaluation of the meaning of capacitance plots for Schottky-barrier-type diodes," *J. Appl. Phys.*, vol. 54, no.4, pp.1966-1975, 1983.

[16] H. H. Tseng, and C. Y. Wu, "A simple technique for measuring the interface-state density of the Schottky barrier diodes using the current-voltage characteristics," *J. Appl. Phys.*, vol. 61, no. 1, pp. 299-304, 1987.

[17] G. Gomila, and J. M. Rubi, "Relation for the non equilibrium population of the interface states: effects on the bias dependence of the ideality factor," *J. Appl. Phys.*, vol. 81, no. 6, pp. 2674-2681, 1997.

[18] G. Gomila, "Effects of interface states on the non-stationary transport properties of Schottky contacts and metal-insulator-semiconductor tunnel diodes," *J. Phys. D: Appl. Phys.*, vol. 32, no. 1, pp. 64-71, 1999.

[19] Zs. Horvath, "Evaluation of the interface state energy distribution from Schottky I-V characteristics," *J. Appl. Phys.*, vol. 63, no. 3, pp. 976-978, 1988.

[20] A. Singh, K. C. Reinhardt, and W. A. Anderson, "InP tunnel metal-insulator-semiconductor devices irradiated with 1 MeV," *J. Appl. Phys.*, vol. 68, no. 10, pp. 4788-4794, 1990.

[21] M. K. Hudait, and S. B. Krupanidhi, "Interface states density distribution in Au/n-GaAs Schottky diodes on n-Ge and n-GaAs substrates," *Mater. Sci. Eng. B*, vol. 87, no. 2, pp. 141-147, 2001.

[22] L. M. Terman, "An investigation of surface states at a silicon at a silicon/silicon oxide interface employing metal-oxide-silicon diodes," *Solid-State Electron.,* vol. 5, no. 5, pp. 285-299, 1962.

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