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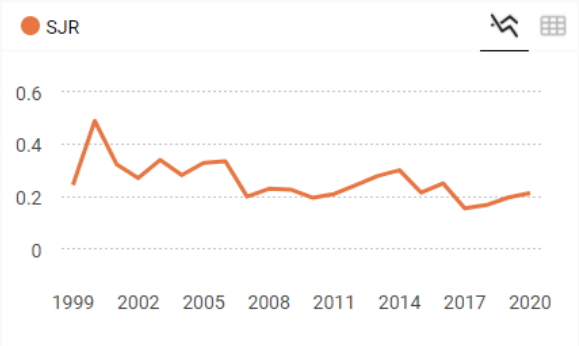

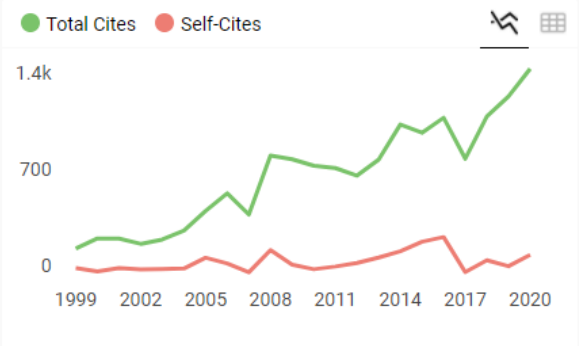

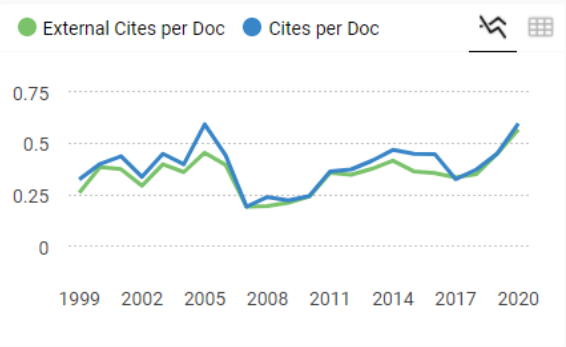

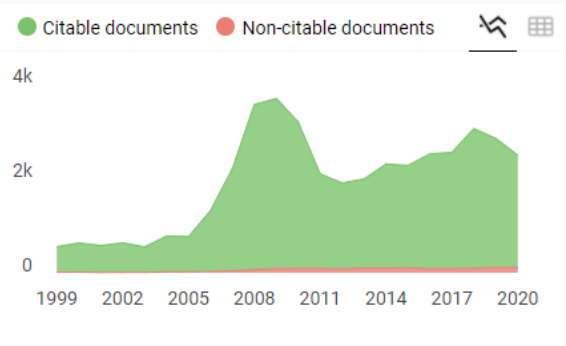

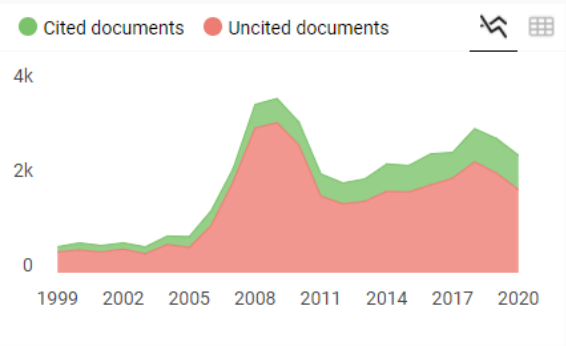

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Introduction

Industry 4.0 is characterized by an increase in a variety of technologies that are the result of the hard work of researchers. It is undeniable that these developments require a variety of supporting materials, one of which is a semiconductor material. The semiconductor material is a material that has a unique characteristic that is flexible, in one condition as a conduit and other conditions can not function as a conduit [1].

The effort made by researchers to maximize the function of semiconductor materials is to modify the shape of the material in the form of thin films. Utilization of thin layers of semiconductor materials including TCO (transparent Conducting Oxide) which is used in transparent electrodes [2], LEDs (Light emitted diode) [3], solar cells [4], LCD [5], gas sensors, [6], etc. Various types of materials used in the synthesis of thin films are aluminum, tungsten disulfide [7], titanium dioxide [8], and tin oxide [9].

The sensitivity of a thin layer is strongly influenced by the value of the energy bandgap of the thin layer. The lower the value of the energy bandgap layer, the more sensitive the material is to conduct current or as a conductor [10]. The energy band gap value of the tin oxide thin layer is still quite high at around 3.62 eV [11], so it needs to be modified by adding another atom to the material. Several other atoms were added namely, aluminum-zinc [12], Ferrum [13], fluorine [14], and indium [15]. The thin layer of tin oxide doped by aluminum has a less transparent surface, as does the addition of fluorine doping. To improve the transparent color of the tin oxide thin layer an investigation was carried out by adding aluminum, fluorine, and indium together as a transparent color enhancer.

Experimental

This research was conducted in several stages, namely synthesis, characterization, and analysis. In the first stage, the synthesis is carried out starting from making sol-gel, preparation of glass substrate, making layers by coating the glass substrate using sol-gel solution, and finally is maturation [16]. The second step, thin layer characterization was carried out to obtain data on the optical properties of the layer using thermoscientific Uv-Vis, and the data obtained also showed morphological appearance and percentage of composition contained in the thin film obtained with SEM-EDX. The third stage, the analysis of optical properties data, the morphological appearance, and the percentage of thin-film content.

Thin-film SnO_2:(Al+F+In) consist of pure SnO_2, 95% SnO_2 doped with a mixture of 5% Al+F+In with a percentage of 33.3% each from 5% mixture, SnO_2 90% doped with a mixture of 10% Al+ F+In with a percentage of 33.3% each from 10% mixture, 85% SnO_2 were doped with a mixture of 15% Al+F+In with a percentage of 33.3% each from 15% mixture, 80% SnO_2 mixed with a mixture of 20% Al+F+In with a percentage of 33.3% each of the 20% mixture, and 75% SnO_2 were doped with a mixture of 25% Al + F + In with a percentage of 33.3% each from the 25% mixture. The thin-film were synthesized using a sol-gel method that is placed on the surface of the glass and the layer smoothing process is rotated using a spin coater [17]. The synthesis was carried out with several variations of doping material, namely 0, 5, 10, 15, 20, and 25%. Thin-film material that has been attached evenly to the glass surface is then heated at a temperature of 150 ^oC using a furnace for 1 hour for all doping concentrations.

The optical properties of the coating are obtained from the thin Uv-Vis thermoscientific which includes the transmittance and absorbance of the thin film. The absorbance value is then used to obtain the energy band gap value [18] and thin-film activation energy [19]. The energy value of the thin layer gap is classified into two, namely direct energy bandgap and indirect energy bandgap. The amount of energy band gap is obtained from the eq. 1 [20].

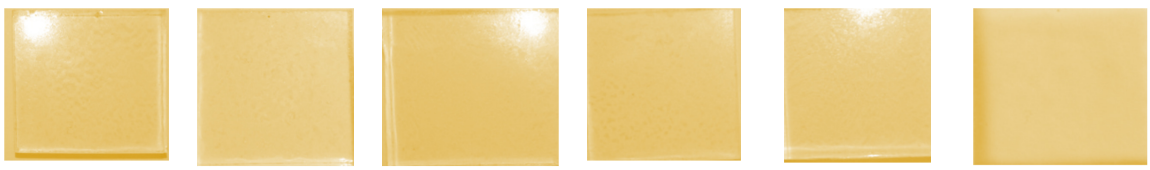
$$\alpha(h\upsilon)h\upsilon = C(h\upsilon - Eg)^n \quad (1)$$

Note: α is the absorbance coefficient, hυ is the incident energy of the photon, C is a constant, n = 1/2 for direct and n = 2 for indirect band-gap energy [21].

Energy gap is also obtained through the graph method $(\alpha h\upsilon)^n$ to the photon energy. The bandgap energy is shown by the slope of the photon energy graph concerning $(\alpha h\upsilon)^n$. While the thin-film activation energy is obtained from 1/m or one per photon energy gradient graph towards ln α, where α were founded from equation $\alpha = 2.303A/d$ (note: A is absorbance, d is thickness).

Result and Discussion

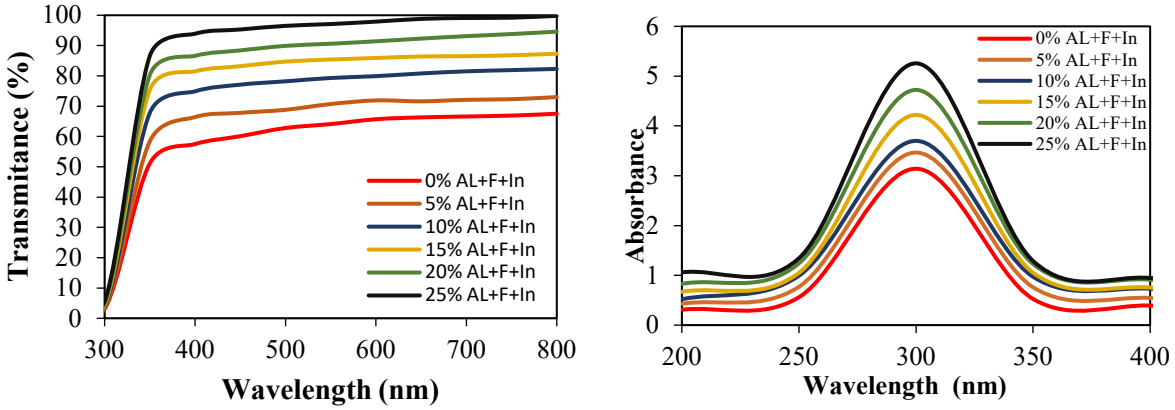
The synthesis of SnO_2 thin film with three aluminum, fluorine and indium doping materials with doping variations causes the thin film to become more transparent, as doping concentrations increase. More clearly the results of the synthesis can be seen in Fig.1.



(a) (b) (c) (d) (e) (f)

Fig. 1 Thin film SnO_2: (Al+F+In) (a) 100: 0%, (b) 95: 5%, (c) 90: 10%, (d) 85: 15%, (e) 80: 20%, (f) 75: 25 %.

The optical properties of SnO_2:(Al+F+In) thin film characterized by UV-Vis Spectrophotometer obtained transmittance and absorbance values as shown in Fig. 2.



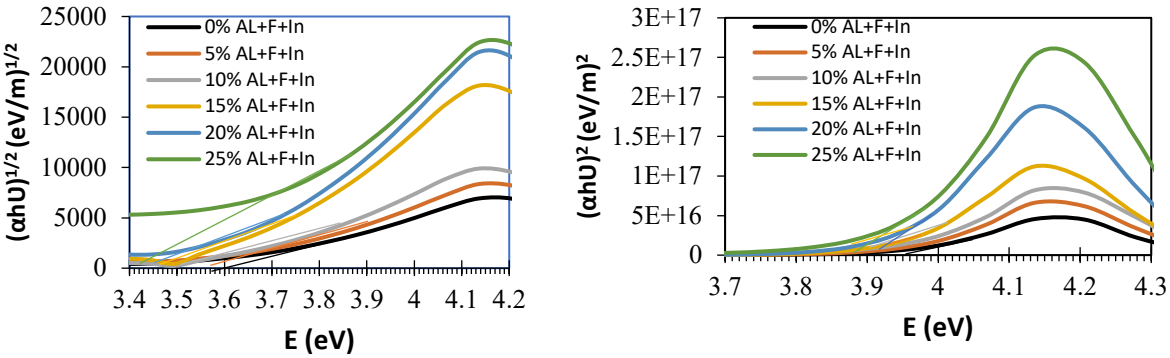
(a) (b)

Fig. 2 Optical properties of SnO_2 and SnO_2: (Al+F+In) thin films in 60 nm, (a) Transmittance of one layer, (b) Absorbance of one layer.

The transmittance value of SnO_2: (Al+F+In) consist of thin films in the wavelength range of 300-800 nm are shown in Fig. 2a. The value of transmittance for the percentage of doping 0-25% is 67.50, 73.00, 82.30, 87.30, 94.6, and 99.80% respectively. This means that the higher the amount of doping aluminum, fluorine, and indium the higher the transmittance value produced [22].

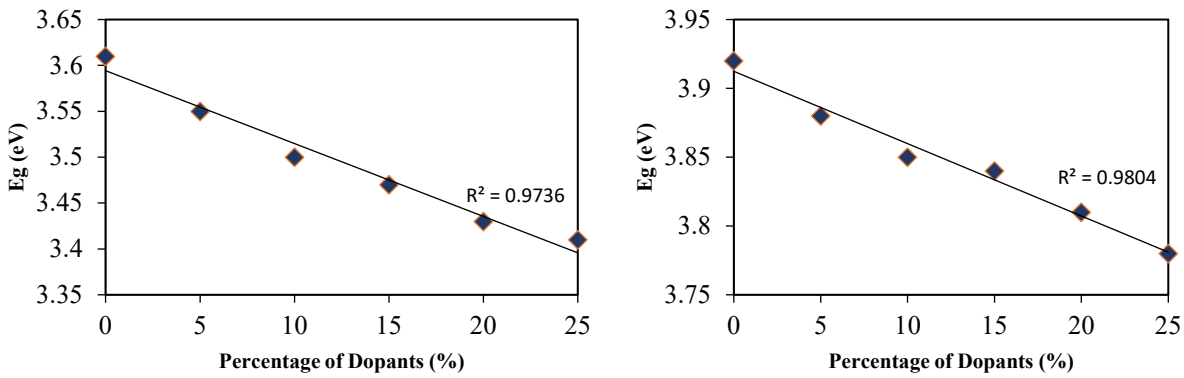
The absorbance value of SnO_2: (Al+F+In thin films in the wavelength range of 300-800 nm is shown in Fig. 2b. The absorbance value for doping percentage is 0-25%, each of them is 0.52, 0.76, 0.97, 1.05, 1.23, and 1.29. This means that the higher the amount of aluminum, fluorine, and indium doping additions the higher the absorbance value produced [23].

Based on eq. 1, obtained direct and indirect energy gaps allowed SnO_2 dan SnO_2:(Al+F+In) thin layer by tauc plot method as shown in the Fig. 3.



(a) (b)

Fig. 3 The energy band gap of SnO_2 and SnO_2:(Al+F+In) thin films. (a) direct allowed, (b) indirect allowed.

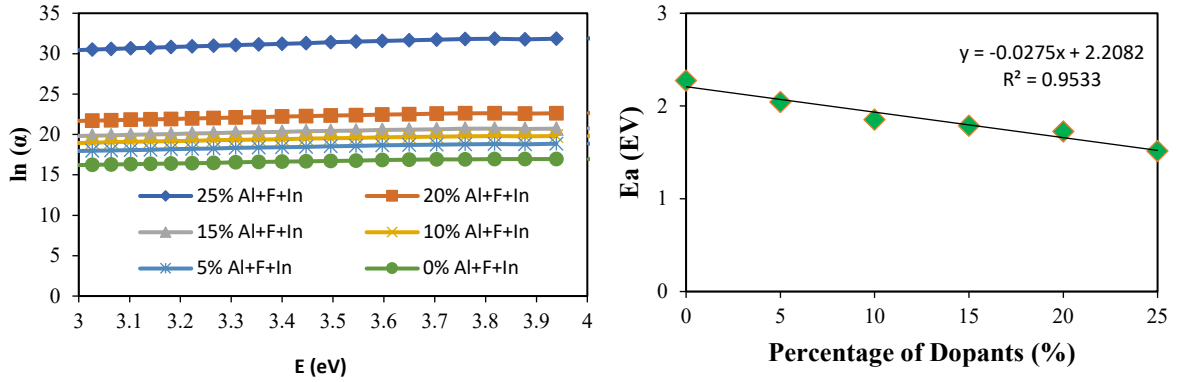


(a) (b)

Fig. 4 The relationship between the percentage of aluminum, fluorine and indium doping with energy bandgap (a) direct allowed, (b) indirect allowed.

The relationship between the percentage of doping with the energy band gap is shown in Fig. 4. Fig. 4a is the energy band gap direct allowed, while Fig. 4b represents the energy band gap direct allowed. The value of the energy band gap direct allowed for doping percentage is 0-25%, each of them is 3.60, 3.55, 3.51, 3.47, 3.43, and 3.41 eV, while energy bandgap indirect allowed values are 3.92, 3.89, 3.88, 3.84, 3.81, and 3.78 eV. This shows that the addition of aluminum, fluorine and indium doping can cause a decrease in the value of the bandgap thin film that were founded from sloope of graph photon energy versus $(\alpha hv)^n$. This means that the smaller the percentage of doping aluminum, fluorine, and indium energy bandgap produced the greater [24, 25]. The decrease in the bandgap energy value indicates that the electron jump from the valence band to the conduction band will be easier.

The value of ln α and activation energy SnO_2 : (Al+F+In) thin film, were follow Arrhenius plot is shown in Fig. 5.



(a) (b)

Fig. 5 Characteristics of optical properties of SnO_2 and SnO_2: Al+F+In thin films. (a) Ln (α), (b) activation energy.

Activation energy values obtained for the percentage of doping aluminum, fluorine and indium 0, 5, 10, 15, 20 and 25% are respectively 2.27, 2.04, 1.85, 1.78, 1.72, and 1.51 eV. In general, the activation energy decreases with increasing doping value. This value means that the electron mobile more quickly in semiconductor material to conduct electricity.

Conclusions

A thin layer of SnO_2 was doped with aluminum, fluorine, and indium (SnO_2: Al + F + In). The optical properties of the layer consist of transmittance, absorbance, energy bandgap, and activation energy. The value of transmittance for the percentage of doping 0-25% increased from 67.50 to 99.80% at 350 nm wavelength, as well as the absorbance increased from 0.52-1.29 at 300 nm wavelength. Besides that the energy bandgap and the resulting activation decreased with an increasing number of doping aluminum, fluorine, and indium.

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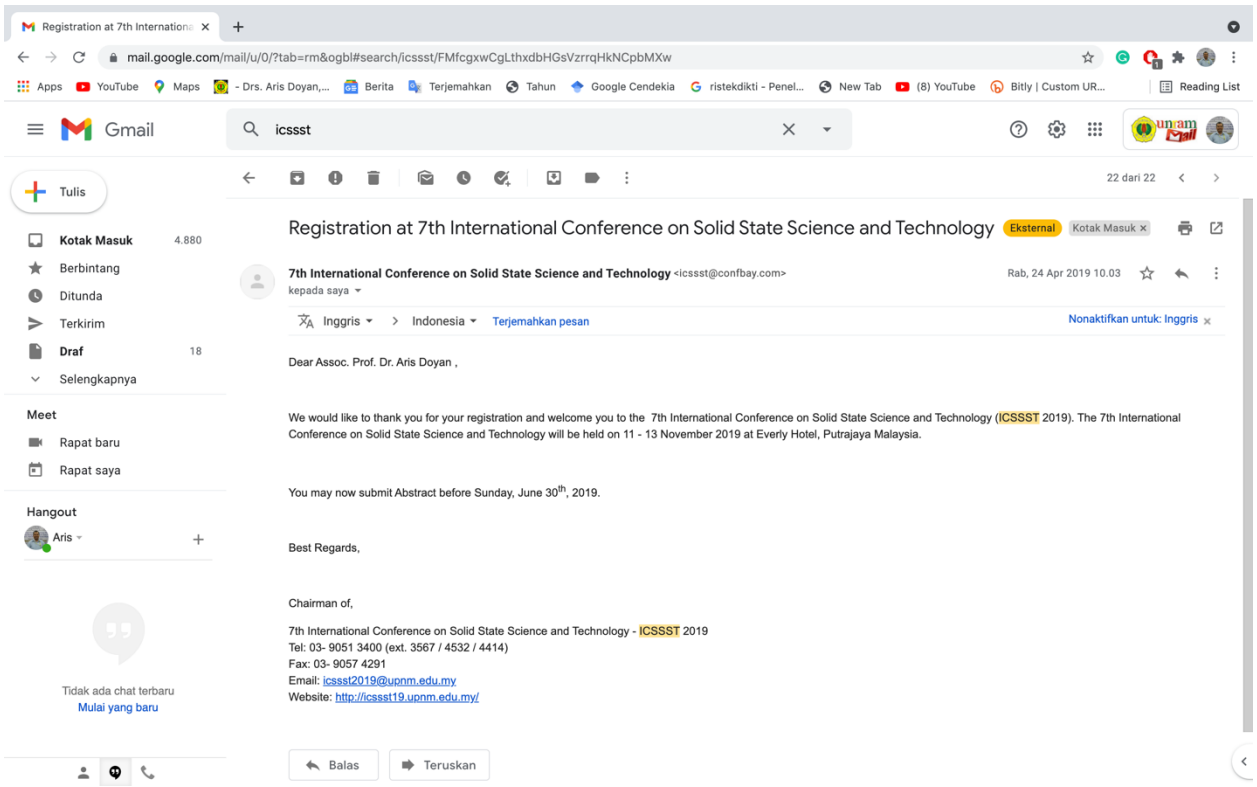
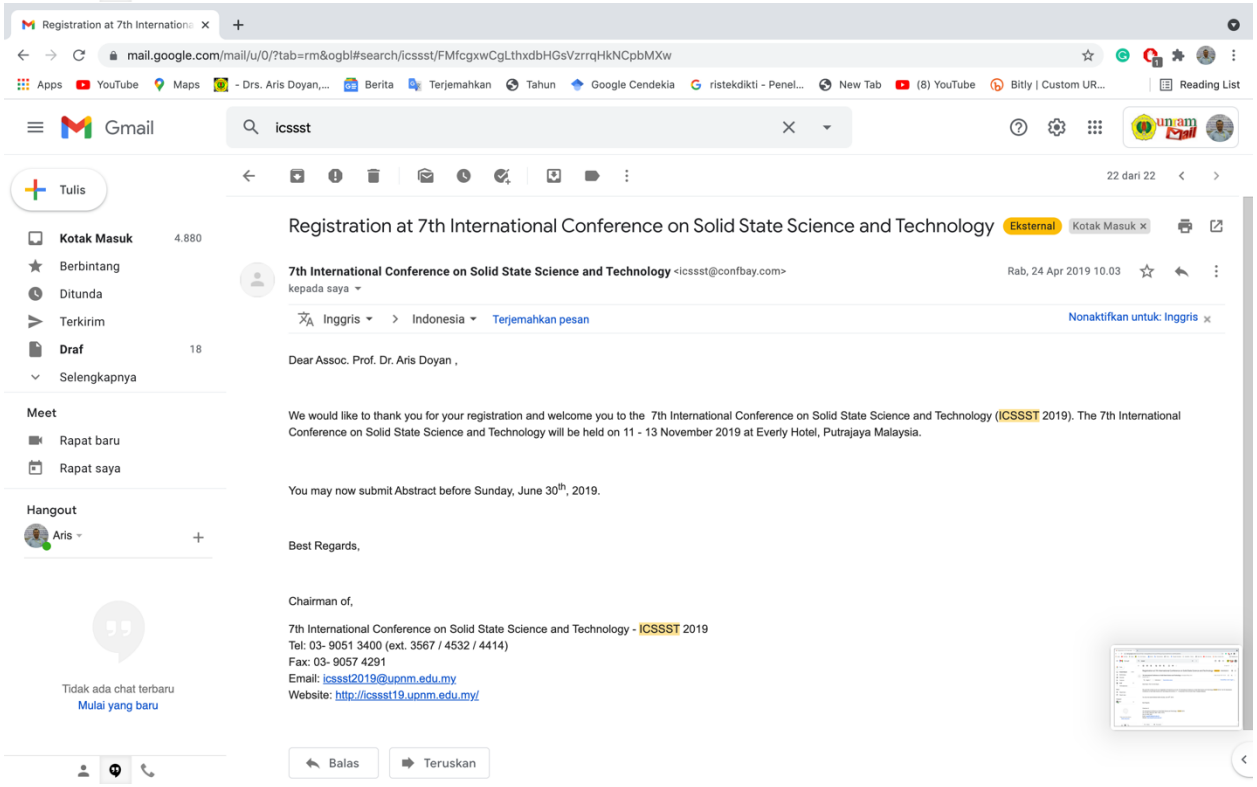
Corresponding Author dengan Pihak ICSST 2019





7th ICSSST 2019 - Aris Doyan, Ph.D

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Dear Assoc. Prof. Dr. Aris Doyan,

You are kindly reminded that the deadline of the Abstract Submission, June 30th, 2019, is approaching. Therefore, we would appreciate it very much if you could submit your abstract at your earliest convenience before the deadline.

To submit abstract and for the latest information on the conference, please visit our website at: http://icssst19.upnm.edu.my/

We are looking forward to receiving your abstract submission.

Thank you.

Best Regards,
ICSSST 2019 Administration
Email: icssst2019@upmn.edu.my
Website: http://icssst19.upnm.edu.my/

Noted with thanks. Thank you for the information. Yes, thank you for the reminder.

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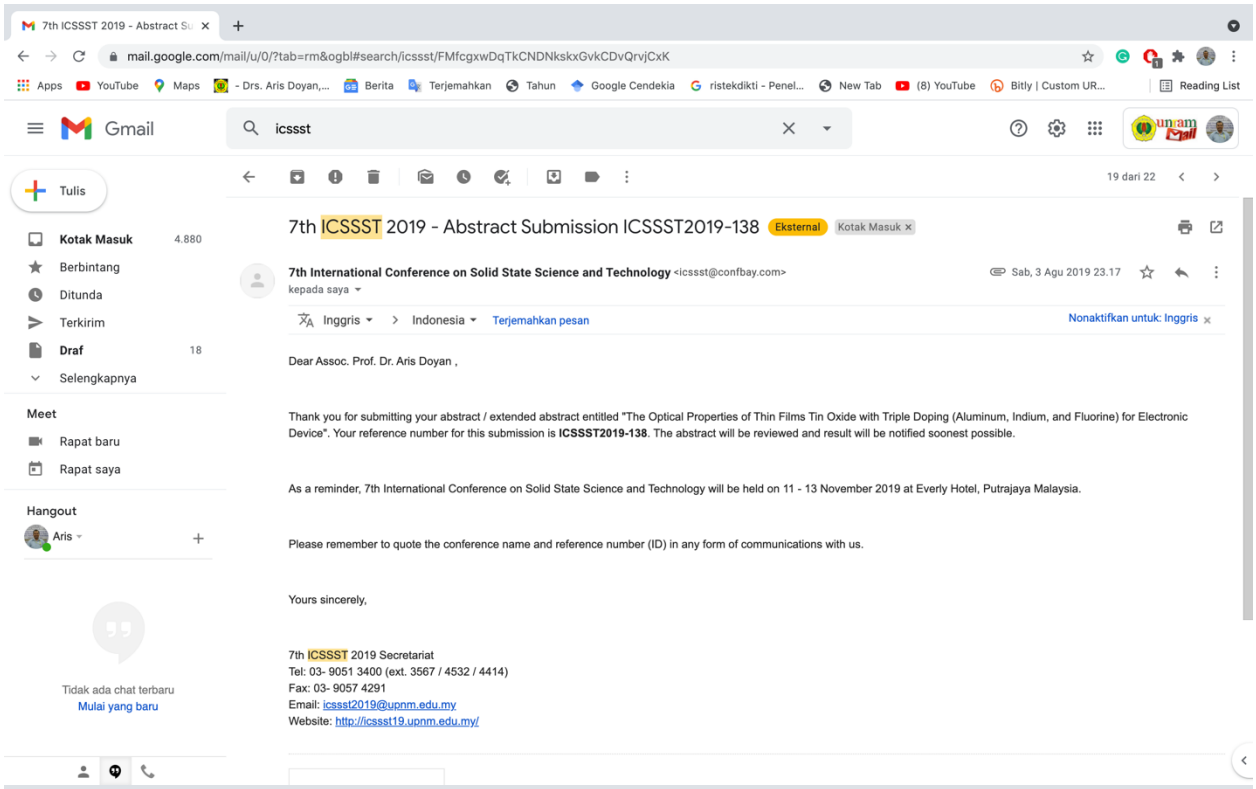
Assalamualaikum PM Dr Aris & PM Dr Susilawati,

Bersama-sama ini disertakan poster 7th ICSSST 2019 yang latest. Mohon hebahkan pada yang berminat.

TQVM.

"DUTY, HONOUR, INTEGRITY"

--
Dr. Wan Yusmawati binti Wan Yusoff
Senior Lecturer
Department of Physics
Centre for Defence Foundation Studies
National Defence University of Malaysia
Kem Sungai Besi
57000 Kuala Lumpur, MALAYSIA.
Tel: 603-90513400 ext 3567
E-mail: yusmawati@upnm.edu.my



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Sab, 3 Agu 2019 23.17

Dear Assoc. Prof. Dr. Aris Doyan ,

Thank you for submitting your abstract / extended abstract entitled "The Optical Properties of Thin Films Tin Oxide with Triple Doping (Aluminum, Indium, and Fluorine) for Electronic Device". Your reference number for this submission is **ICSSST2019-138**. The abstract will be reviewed and result will be notified soonest possible.

As a reminder, 7th International Conference on Solid State Science and Technology will be held on 11 - 13 November 2019 at Everly Hotel, Putrajaya Malaysia.

Please remember to quote the conference name and reference number (ID) in any form of communications with us.

Yours sincerely,

7th ICSSST 2019 Secretariat
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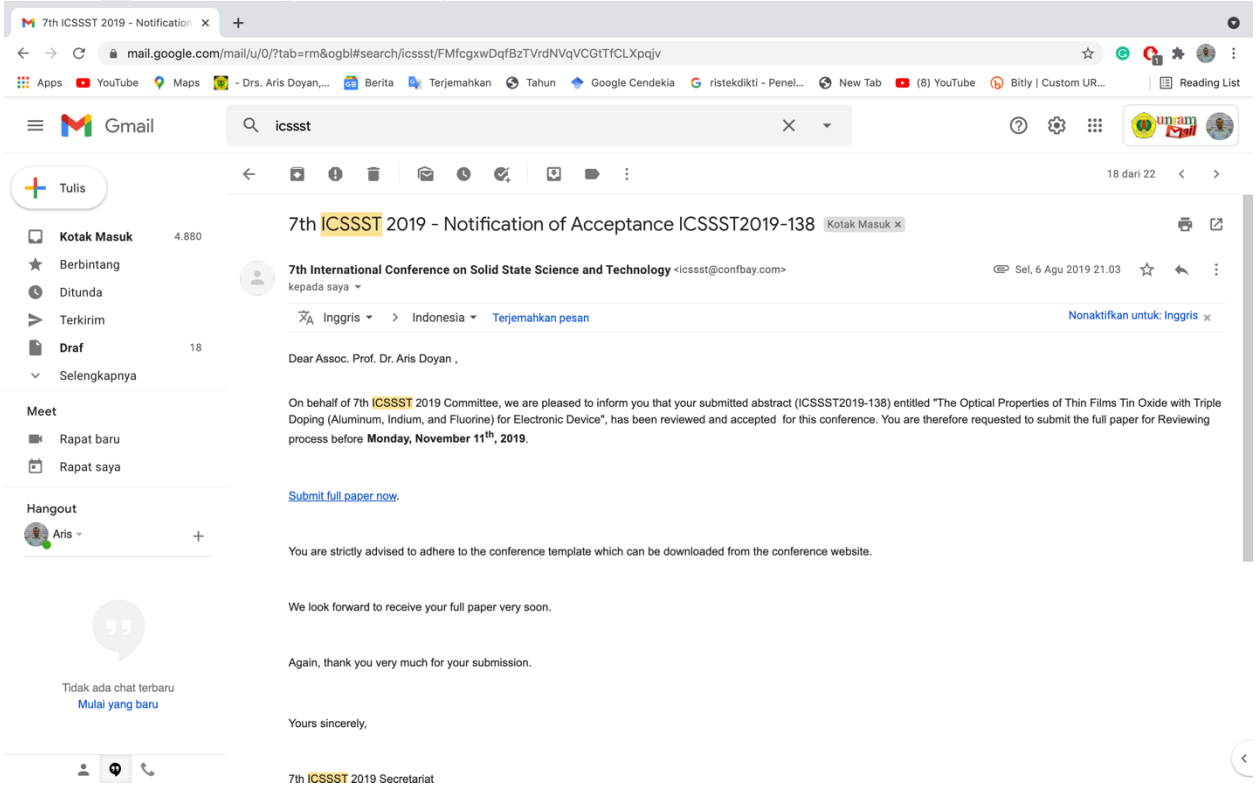
Fax: 03- 9057 4291
Email: icssst2019@upnm.edu.my
Website: http://icssst19.upnm.edu.my/



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Sel, 6 Agu 2019 21.03

Dear Assoc. Prof. Dr. Aris Doyan ,

On behalf of 7th ICSSST 2019 Committee, we are pleased to inform you that your submitted abstract (ICSSST2019-138) entitled "The Optical Properties of Thin Films Tin Oxide with Triple Doping (Aluminum, Indium, and Fluorine) for Electronic Device", has been reviewed and accepted for this conference. You are therefore requested to submit the full paper for Reviewing process before **Monday, November 11th, 2019**.

Submit full paper now.

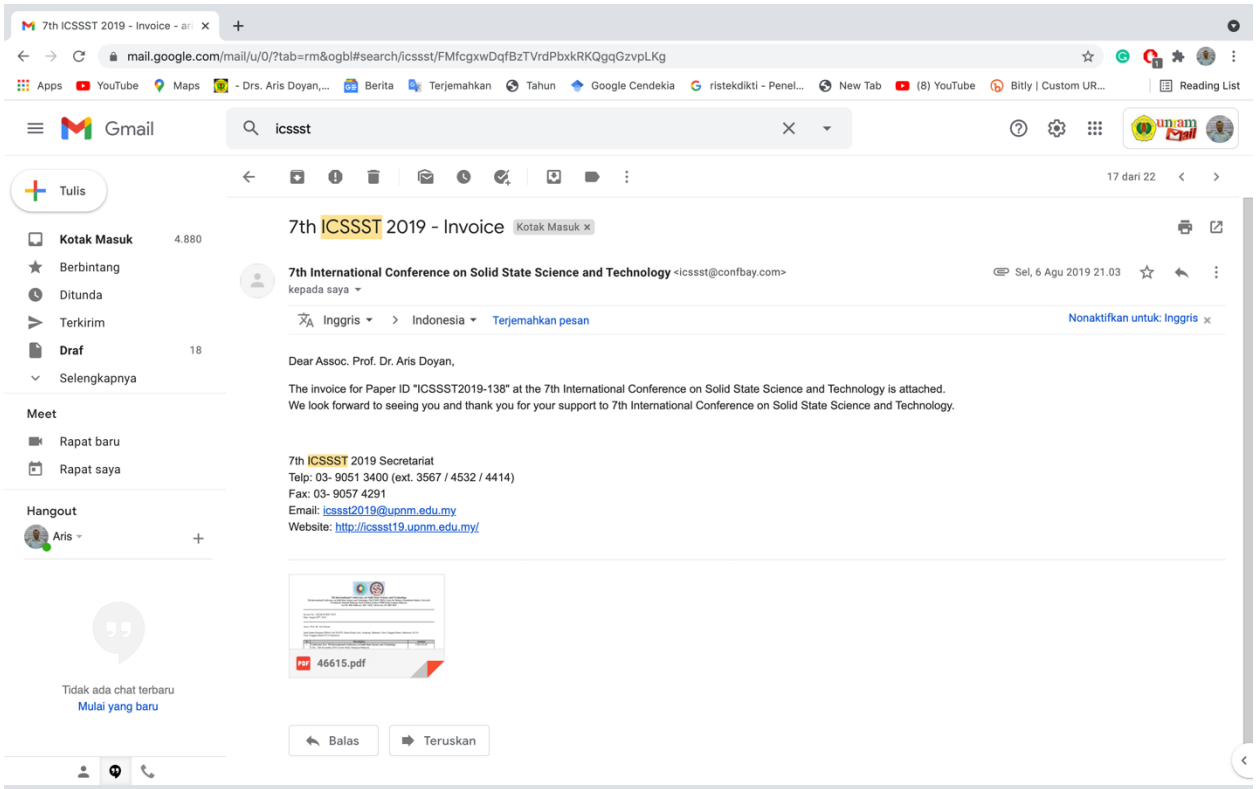
You are strictly advised to adhere to the conference template which can be downloaded from the conference website.

We look forward to receive your full paper very soon.

Again, thank you very much for your submission.

Yours sincerely,

7th ICSSST 2019 Secretariat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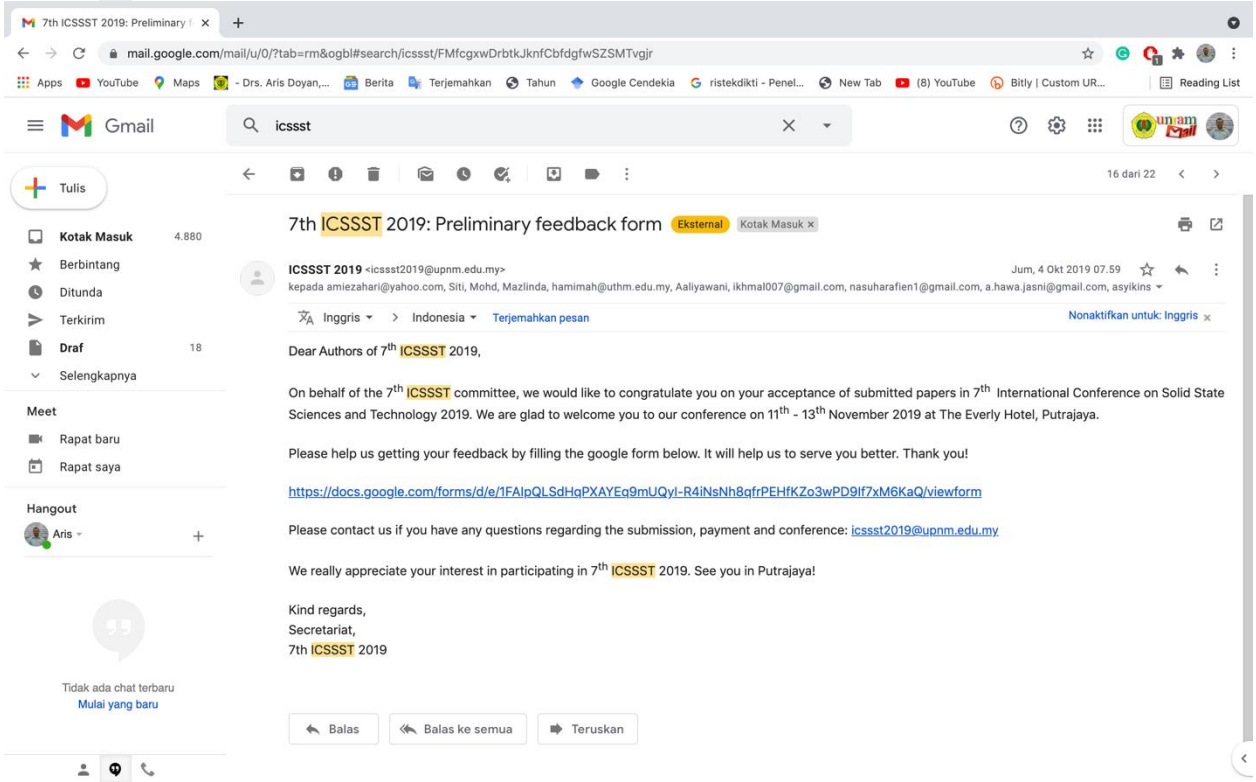
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Please help us getting your feedback by filling the google form below. It will help us to serve you better. Thank you!
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Please contact us if you have any questions regarding the submission, payment and conference: icssst2019@upnm.edu.my
We really appreciate your interest in participating in 7th ICSSST 2019. See you in Putrajaya!
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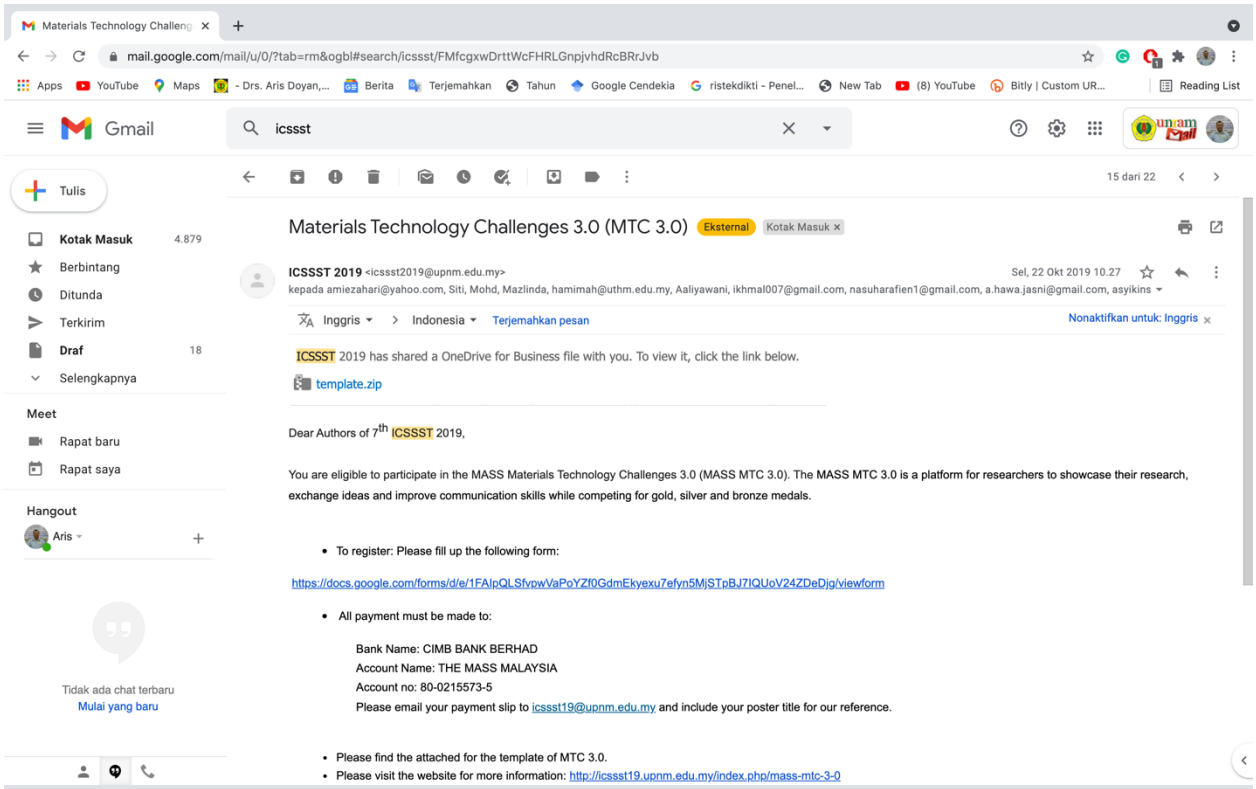

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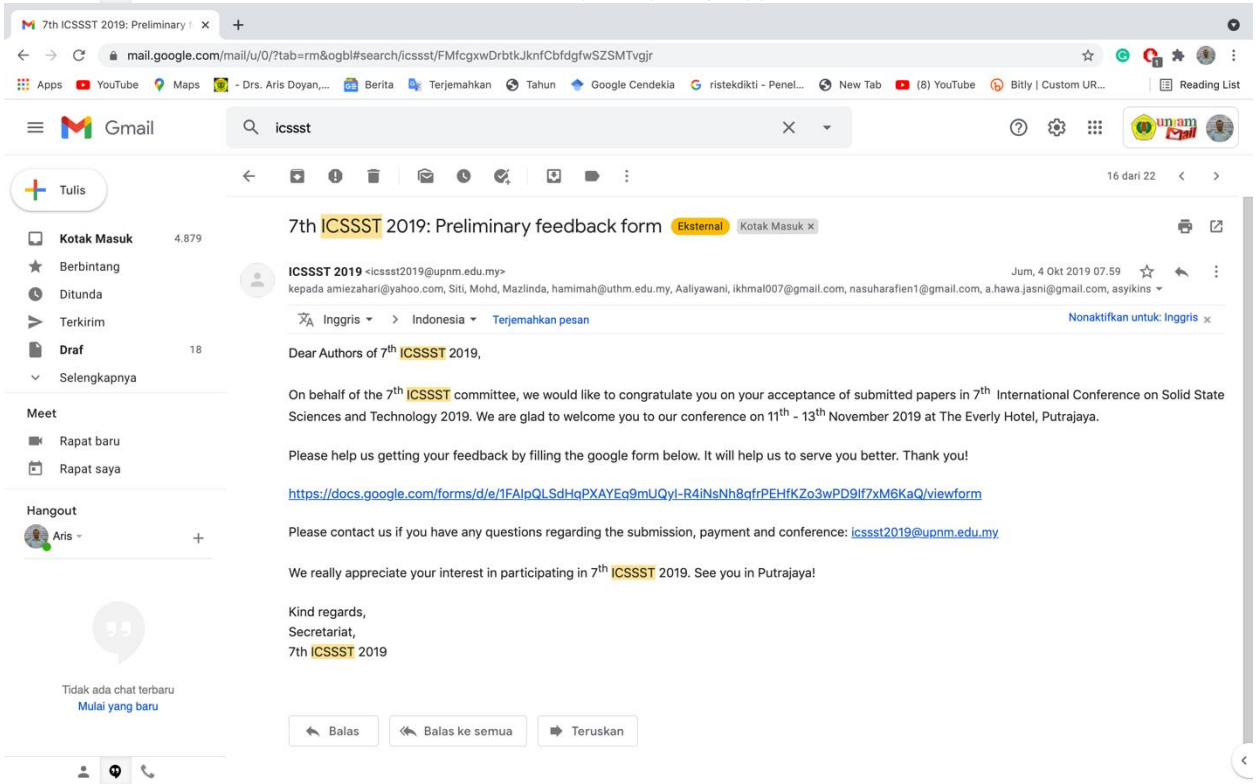

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We really appreciate your interest in participating in 7th ICSSST 2019. See you in Putrajaya!

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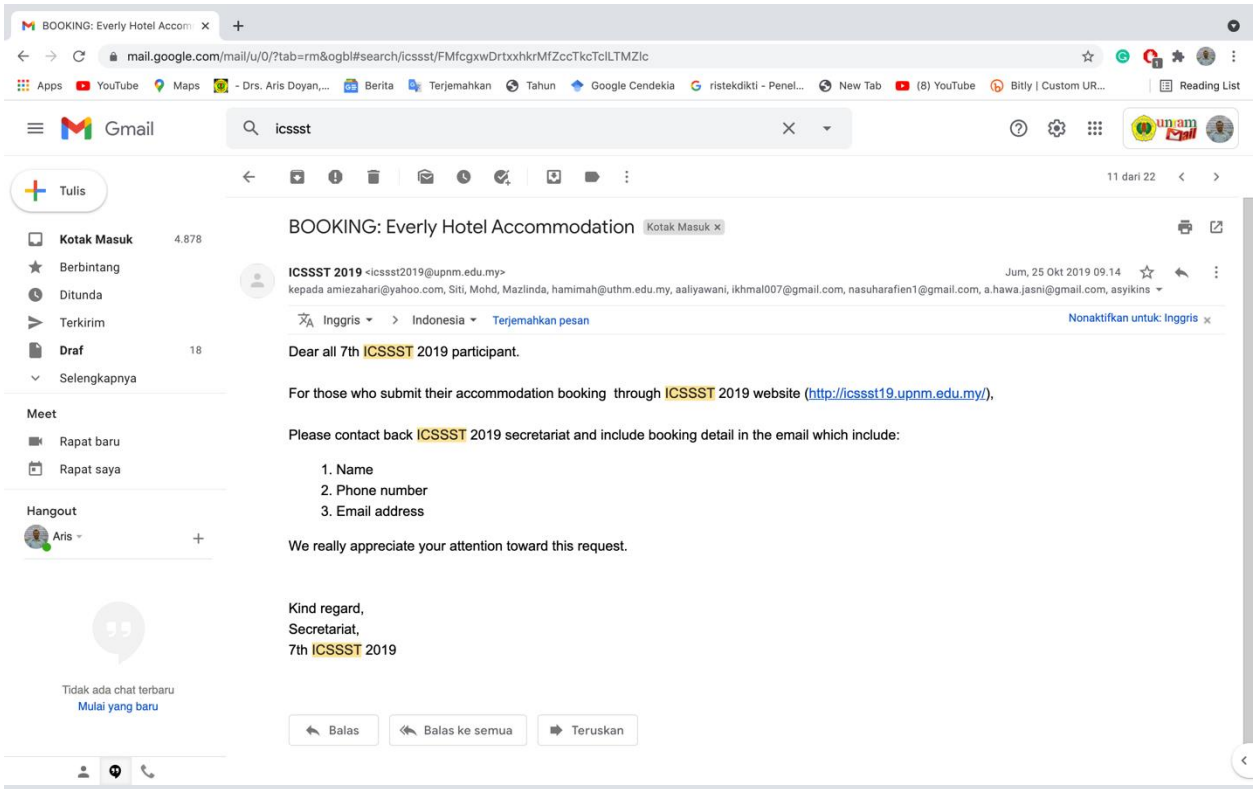
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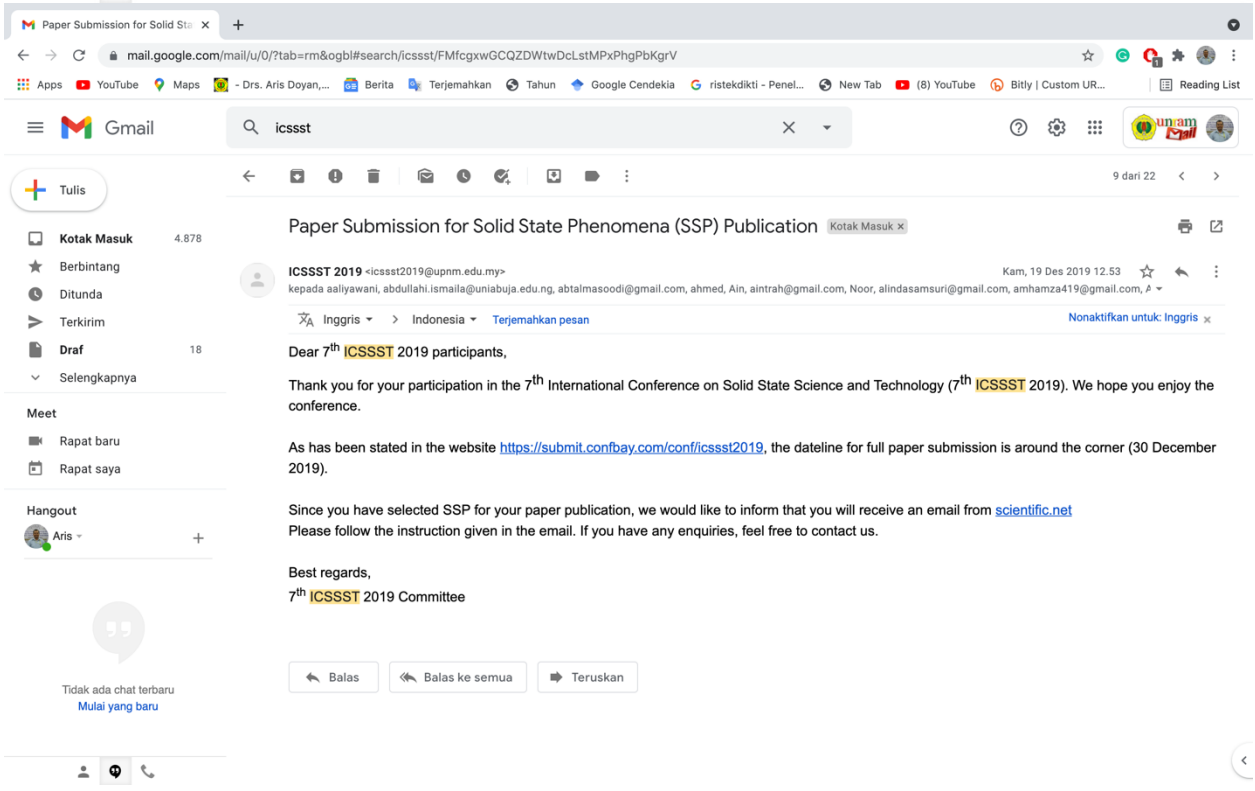
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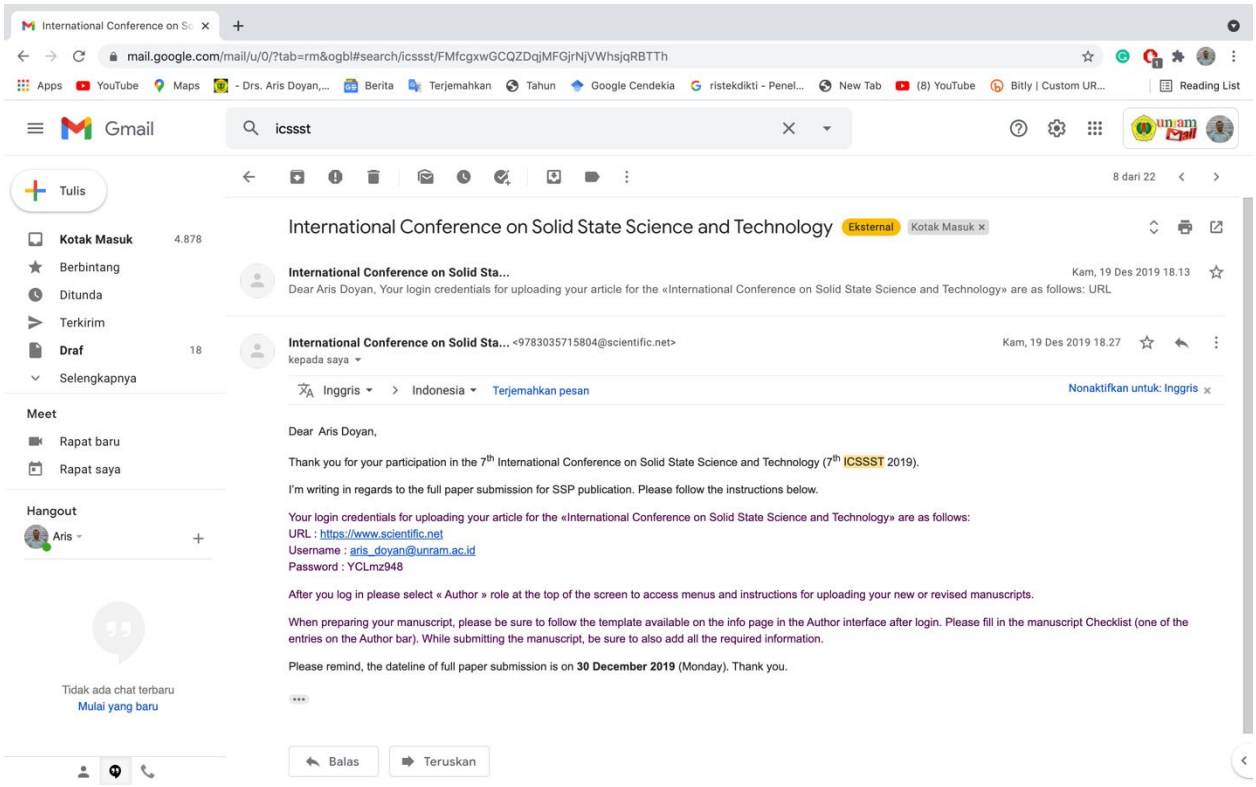
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Biaya koresponden *correspondent charge*	
Sub Total	
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Status kependudukan *resident status*: ☐ penduduk *resident* ☐ bukan penduduk *non-resident*

Nama *name*: DRS. ARIS DOYAN, MSi. Ph.D

Alamat & nomor telepon *address & telephone number*: JL. Sunan Bonang II no 20 Kodya ASKI

METODE TRANSAKSI (wajib diisi) *method of transaction*: ☐ tunai *cash* ☑ debet rekening *debit account*: 1610000663885 ☐ cek/bilyet giro *cheque*

Bank Tertarik *drawee bank*	No.cek/BG *cheque number*	Valuta *currency*	Nominal *amount*

Jumlah setoran/transfer/kliring/inkaso *deposit/transfer/clearing/collection amount*: $ 73

Terbilang *in words*: TUJUH PULUH TIGA DOLLAR U.S

SUMBER DANA TRANSAKSI (wajib diisi) *source of fund*: ☐ Gaji / penghasilan *salary / income* ☑ Tabungan / hasil investasi *savings / investment* ☐ Warisan *inheritance* ☐ Dana pemerintah *Government Funds* ☐ Hibah / hadiah *Grants / gifts* ☐ Penjualan aset *sale of assets* ☐ Hasil Usaha *business proceed* ☐ Sumbangan *contribution*

BIAYA TRANSAKSI *transaction fee*: ☐ Tunai *cash* ☑ Debet rekening *debit account*:

Biaya bank koresponden *correspondent charge*: ☐ Pengirim *applicant* ☐ Penerima *beneficiary* ☐ Lainnya *others*

diisi apabila pembawa formulir bukan Pengirim *filled out if the bearer of this form is not the applicant*

Nama *name*:

Alamat & nomor telepon *address & telephone number*:

NIK/ Paspor (WNA) *ID number*: