Analisis Molekular dan Transpor Ion Natrium Silikat

Dinda Purnama Kristy¹, Rahadian Zainul²

¹Pendidikan Kimia, FMIPA, Universitas Negeri Padang, Indonesia

²Physical Chemistry Laboratory, FMIPA, Universitas Negeri Padang, Indonesia

*E-mail : ¹dindapurnamakristy@gmail.com
²rahadianzainul@yahoo.com

Abstrak. *Natrium Silikat* adalah nama umum untuk senyawa dengan rumus kimia Na_2SiO_3 . Senyawa ini lebih dikenal dengan nama natrium metasilikat, waterglass atau gelas cair. Tujuan review ini adalah untuk mengetahui karakteristik molekul dan transpor ion Natrium Silikat. Metode yang digunakan untuk mengetahui karakteristik molekul yaitu metode pemodelan komputasi di *ChemOffice* 15.0, dan untuk mengetahui transpor ion Natrium Silikat yaitu dengan parameter konduktivitas, viskositas, mobilitas ion, dan gerakan hanyut. Hasil yang didapat yaitu struktur molekul Natrium Silikat pada analisis molekuler 2D, dan bentuk molekul Natrium Silikat dalam 3D. Dengan nilai sifat termodinamika Natrium Silikat yaitu C 111,8 J/molK, ΔS° 113,71 J/molK, ΔG -1427 kJ/mol, serta larutan Na_2SiO_3 memiliki konduktivitas yang bergantung luas permukaan, mobilitas Ion yaitu 5,19, kekuatan tarik anion 110 mpa, viskositas yang beragam tergantung spesinya,

Kata Kunci: *Natrium Silikat, Molekul, Transpor Ion.*

1. Pendahuluan

Natrium silikat cukup terkenal dikalangan industri⁽²⁸⁻³⁰⁾, karena natrium silikat digunakan sebagai bahan baku pembuatan silica gel^(31; 32), bahan tambahan dalam pembuatan semen⁽³⁷⁾. Natrium silikat disintesis dari pasir kuarsa dengan larutan alkali. Pasir kuarsa merupakan hasil alam yang melimpah di Indonesia^(38; 39). Berdasarkan data dari berbagai sumber, menjelaskan bahwa pasir kuarsa memiliki kandungan silica sekitar 55,3 – 99,7%^(40; 41).

Silikat, dalam ilmu kimia adalah suatu senyawa anion dengan satu atom silicon pusat yang dikelilingi oleh ligan elektronegatif⁽⁴²⁻⁴⁷⁾. Anion silikat, dengan muatan listrik negative, harus mendapatkan pasangan kation lain untuk membentuk senyawa bermuatan netral^(21; 48-50). Kation yang digunakan disini yaitu Na^+ . Komposisi murni tidak berwarna atau putih, tetapi commercial sample sering kehijauan atau biru karena adanya kotoran⁽⁵¹⁻⁵³⁾. Senyawa ini digunakan sebagai perekat, formulasi semen, perlindungan api pasif, pengolahan tekstil dan kayu, pembuatan keramik tahan api, dan produksi silica gel^(30; 54-60).

Na_2SiO_3 mempunyai ikatan ionic yang terbentuk dengan kecenderungan atom menangkap atau melepas elektron agar stabil seperti konfigurasi gas mulia⁽⁶¹⁾. Reaksi pembuatan Natrium Silikat:

Pada awalnya, Natrium Silikat diproduksi dengan cara memanaskan pasir kuarsa dan Na_2CO_3 dalam tungku pemanas (furnace) pada suhu 1400°C ^(61; 62) menurut reaksi kimia:

Namun saat ini, Natrium Silikat dapat diproduksi dari bahan-bahan yang mengandung silica dengan cara ekstraksi dengan larutan alkali. Oleh karena itu, Natrium Silikat dapat dibuat pada suhu yang relative rendah yaitu $95-105^\circ\text{C}$ ^(17; 22; 63) menurut reaksi kimia berikut:

Biasanya, Natrium Silikat dibuat dari pasir silica atau pasir kuarsa. Jumlah pasir silica yang digunakan sangat banyak, untuk setiap pabrik bisa mencapai ribuan ton setiap minggunya⁽⁶⁴⁻⁶⁷⁾. Langkah pertama yang dilakukan adalah mencuci pasir silica dengan menggunakan air. Hal ini

berfungsi untuk memisahkan pasir dari tanah atau zat-zat pengotor lain yang masih tercampur dengan pasir. Setelah itu, pasir silica ditumbuk dalam keadaan masih basah, namun tidak bercampur dengan air berlebih^(17; 22). Hal ini berfungsi untuk memudahkan dalam proses penumbukan pasir. Setelah pasir silica halus, langkah selanjutnya adalah mengeringkan pasir silica tersebut pada suhu 100°C selama 2 jam. Ini bertujuan untuk, membebaskan air dari pasir silica, yang mana air akan menguap pada suhu lebih dari 100°C^(23; 63).

Setelah itu pasir silika diayak, langkah ini merupakan pengolahan pasir silika sebelum direaksikan dengan senyawa alkali. Ukuran pasir silika yang dipakai adalah (35/40) dan (50/60) mesh. Setelah penumbukan pasir yang bertujuan agar pasir silika cepat larut ketika direaksikan dengan senyawa alkali⁽⁶⁸⁻⁷⁰⁾.

Selanjutnya, pasir silika direaksikan dengan NaOH (Larutan Alkali) pada suhu 95-105°C sampai silika larut. Setelah itu dilakukan filtrasi dalam keadaan masih panas. Residu yang dihasilkan dibuang. Filtrate yang dihasilkan dikristalisasi sampai terbentuk bongkahan atau butiran dengan ukuran besar⁽⁷¹⁻⁷³⁾. Silika yang murni berwarna putih.

2. Metodologi

Review ini menggunakan pemodelan komputasi⁽⁷⁴⁾ dengan menggunakan aplikasi Chem Office 15.0 (Chem Ultra versi 15 dan Chemdraw versi 15). Review dilakukan beberapa tahapan, yakni (1) Analisis molekul Na_2SiO_3 secara dua dimensi menggunakan Chemdraw Ultra; (2) Analisis molekul secara tiga dimensi ChemDraw Ultra dan diproyeksikan pada Chem 3D. Pemodelan ini dengan mengasumsikan pada satu molekul Na_2SiO_3 dengan beberapa kemungkinan pergerakan dan vibrasional yang terjadi^(75; 76).

Molekul Na_2SiO_3 mulanya dilukis dengan menggunakan software dari Chemdraw Ultra dengan cara pilih *Structure*, pilih bagian bawah “*Convert Name to Structure*”. Selanjutnya akan muncul pada layar kerja, tulis Na_2SiO_3 , lalu pilih OK. Setelah Rumus Molekul Natrium Silikat terbentuk, lakukan analisis senyawa. Proses analisis dilakukan pada bagian View, dengan optional show analysis window dan show chemical properties windows.

Pada analisis 3D dilakukan dengan mentransformasikan molekul 2D ke Chem 3D. Pada bagian ChemBio 3D, struktur Na_2SiO_3 menjadi 3 Dimensi dan dapat dianalisis kondisi sebelum optimasi dengan pilihan select, sesuai pengukuran dan observasi yang diinginkan. Misalnya, pada pengukuran jarak antara atom Na_2SiO_3 , maka dapat dilakukan dengan meletakkan kursor pada bagian penghubung bentuk 3D dari molekul Na_2SiO_3 tersebut, untuk calculation pada energy, molecular dynamics, compute properties maka dapat dilakukan dengan mengklik menu toolbar “MM2”, untuk calculation Extended Huckel Surface dan Extended Huckel Charge dapat dilakukan dengan mengklik menu toolbar “Analyze” selanjutnya memilih optional Extended Huckel Surface dan Extended Huckel Charge.

Untuk analisis besaran kimia fisika 3 menggunakan metode pengolahan data yang ada. Setelah semua dianalisis molecular dan besaran kimia fisika digunakan software *EndNote* untuk mensitasi referensi.

3. Analisis GAP

Pada saat ini, Natrium Silikat digunakan untuk merekatkan semen, untuk melindungi keramik dari api, untuk melodorkan tekstil dan kayu^(68; 77). Natrium silikat ini diproduksi dari pasir silica atau pasir kuarsa^(78; 79). Telah menjadi rahasia public bahwa pasir silica yang murni harganya mahal. Sedangkan pasir silica yang dibutuhkan untuk membuat natrium silikat sendiri itu membutuhkan jumlah sangat yang banyak^(68; 80). Dengan demikian, Natrium silikat dapat disintesis dengan menggunakan pasir kuarsa atau pasir silica dari bahan limbah atau pembuangan seperti limbah sekam padi yang mengandung sekitar 15-30% silica^(78; 79). Selain itu, limbah industri yang merupakan limbah dari kegiatan pertambangan⁽⁸¹⁻⁸³⁾, seperti banyak dijumpai dipertambangan emas di Papua berbentuk bubuk halus dan sangat ringan, limbah ini mengandung silica yang sangat tinggi^(84; 85).

Sintesis pasir silica dari bahan limbah akan mengurangi dan bahkan menghilangkan dampak negative dari limbah itu sendiri⁽⁸⁶⁻⁸⁸⁾. Selain itu, dengan mengolah limbah industry menjadi bahan bangunan seperti pasir silica ini merupakan langkah maju untuk pengupayaan limbah industry yang dapat bermanfaat dan bernilai tinggi^(89; 90).

4. Pembahasan

1.Result

Sifat	
Rumus kimia	Na_2SiO_3
Massa molar	122,06 g/mol (3; 58; 91)
Penampilan	Padatan Putih(92)
Bau	Tidak Berbau
Densitas	2,61 g/cm ³ (93)
Titik lebur	1088°C
Kelarutan dalam air	22,2 g/100 mL (25°C)

160,6 g/100 mL (80°C) (94-96)

Indeks bias (n_D)

1,52

Tabel 1. Sifat fisika dan kimia Natrium Silikat^(58; 91; 97)

2. Data Molekul

Gambar 1. Molekul Natrium Silikat

-----MM2 Minimization-----

Warning: Some parameters are guessed (Quality = 1).

Iteration 66: Minimization terminated normally because the gradient norm is less than the minimum gradient norm

Stretch	: 0.0285
Bend	: 0.3107
Stretch-Bend	: 0.0170
Torsion	: 0.0000
Non-1,4 VDW	: -0.0548
1,4 VDW	: -0.6892
Charge/Charge	: 33.5796
Total	: 33.1919

3. Bentuk Molekul

a) Analisis 2D pada molekul Na_2SiO_3

Molekul Na_2SiO_3 dibuat dengan menggunakan Chemdraw Ultra dihasilkan karakterisasi sebagai berikut:

sodium metasilicate

Gambar 2. Struktur Na_2SiO_3 ^(98; 99)

$\text{Na}_2\text{O}_3\text{Si}$

Exact Mass: 121,94

Mol. Wt.: 122,06

m/e: 121,94 (100,0%), 122,94 (5,1%), 123,94 (3,4%)

Na, 37.67; O, 39.32; Si, 23.01

CLogP: -1.316

2) Analisis 3D pada molekul Na_2SiO_3

Molekul Na_2SiO_3 dibuat dengan menggunakan Chemdraw Ultra diproyeksikan pada Chem 3D untuk analisis 3 Dimensi. Proses ini akan membantu untuk melihat pola pergerakan molekul secara optimal dan kemungkinan dinamika interaksi Na_2SiO_3 dengan H_2O .

Gambar 3. Analisis 3D pada molekul Na_2SiO_3 model Ball and Stick. (A) molekul Na_2SiO_3 terdiri dari 2 buah atom Na (bola abu-abu), 1 buah atom Si (bola ungu), 3 buah atom O (bola merah), dan 1 buah atom H (bola putih), (B) molekul Na_2SiO_3 dengan 4 Pasang Elektron Bebas (PEB, bola pink) dan (C) molekul Na_2SiO_3 pada permukaan molekul

Gambar 4. Analisis 3D Surface Na_2SiO_3 , (A) Surface Solvent Accessible molekul Na_2SiO_3 Display Solid (B) Surface Solvent Accessible molekul Na_2SiO_3 Display Mode Translucent (C) Surface Solvent Accessible molekul Na_2SiO_3 Display Mode Wire Mesh

3) Optimasi Molekul Na_2SiO_3 menggunakan Molecular Mechanic (MM2)

Optimasi molekul Na_2SiO_3 dilakukan dengan Molekular Mekanik (MM2) dan menghasilkan output data dalam bentuk data geometri atom atom dalam molekul dan Energi optimumnya. Hasil output yang diolah dapat dilihat sebagai berikut :

1. Optimasi MM2 Minimization
2. Optimasi MM2 Dynamics
3. Optimasi MM2 Properties

Output MM2 Minimization, Dynamics dan Properties

-----MM2 Properties-----

Warning: Some parameters are guessed (Quality = 1).

Stretch	: 0.0000
Bend	: 0.0010
Stretch-Bend	: -0.0000
Torsion	: 0.0000
Non-1,4 VDW	: -0.0898
1,4 VDW	: -0.7205
Charge/Charge	: 39.6616
Total	: 38.8522
cubic stretch	: -2.0000
quartic stretch	: 2.3330
p->dielec	: 1.5000
p->dieled	: 1.5000

Bond	Length	R(0)	K(S)	Energy	
Si-O	1.758	1.7580	5.0000	0.0000	Si(1)-O(2)
Si-O	1.758	1.7580	5.0000	0.0000	Si(1)-O(3)
Si-O	1.758	1.7580	5.0000	0.0000	Si(1)-O(5)
Si-H	1.470	1.4700	5.0000	0.0000	Si(1)-H(7)
O-Na	2.180	2.1800	5.0000	0.0000	O(3)-Na(4)
O-Lp	0.650	0.6500	5.0000	0.0000	O(3)-Lp(8)
O-Lp	0.650	0.6500	5.0000	0.0000	O(3)-Lp(9)
O-Na	2.180	2.1800	5.0000	0.0000	O(5)-Na(6)
O-Lp	0.650	0.6500	5.0000	0.0000	O(5)-Lp(10)
O-Lp	0.650	0.6500	5.0000	0.0000	O(5)-Lp(11)

Atom Pair	R	R#	RV	KV	Energy (1,4)	
O,Na	3.605	R#	3.3400	0.0890	-0.0910	4 O(2),Na(4)
O,Na	4.819	R#	3.3400	0.0890	-0.0218	4 O(2),Na(6)
O,Lp	2.945	R#	2.9400	0.0325	-0.0380	4 O(2),Lp(8)
O,Lp	3.423	R#	2.9400	0.0325	-0.0248	4 O(2),Lp(9)
O,Lp	2.944	R#	2.9400	0.0325	-0.0380	4 O(2),Lp(10)
O,Lp	2.944	R#	2.9400	0.0325	-0.0380	4 O(2),Lp(11)
O,Na	3.606	R#	3.3400	0.0774	-0.0791	4 O(3),Na(6)
O,Lp	2.945	R#	2.9400	0.0283	-0.0331	4 O(3),Lp(10)
O,Lp	3.423	R#	2.9400	0.0283	-0.0216	4 O(3),Lp(11)
Na,O	4.819	R#	3.3400	0.0774	-0.0190	4 Na(4),O(5)
Na,Na	5.581	R#	3.2000	0.1200	-0.0096	Na(4),Na(6)
Na,H	3.488	R#	3.1000	0.0751	-0.0697	4 Na(4),H(7)
Na,Lp	4.959	R#	2.8000	0.0438	-0.0032	Na4,Lp10
Na,Lp	5.257	R#	2.8000	0.0438	-0.0022	Na4,Lp11
O,Lp	2.944	R#	2.9400	0.0283	-0.0331	4 O(5),Lp(8)
O,Lp	2.944	R#	2.9400	0.0283	-0.0331	4 O(5),Lp(9)
Na,H	3.482	R#	3.1000	0.0751	-0.0701	4 Na(6),H(7)
Na,Lp	3.790	R#	2.8000	0.0438	-0.015	4 Na(6),Lp(8)
Na,Lp	3.255	R#	2.8000	0.0438	-0.0337	Na(6),Lp(9)
H,Lp	3.174	R#	2.7000	0.0274	-0.0233	4 H(7),Lp(8)
H,Lp	2.743	R#	2.7000	0.0274	-0.0318	4 H(7),Lp(9)
H,Lp	3.171	R#	2.7000	0.0274	-0.0233	4 H(7),Lp(10)
H,Lp	2.741	R#	2.7000	0.0274	-0.0318	4 H(7),Lp(11)
Lp,Lp	2.872	R#	2.4000	0.0160	-0.0108	Lp8,Lp10
Lp,Lp	3.524	R#	2.4000	0.0160	-0.0035	Lp8,Lp11
Lp,Lp	3.062	R#	2.4000	0.0160	-0.0078	Lp9,Lp10
Lp,Lp	3.524	R#	2.4000	0.0160	-0.0035	Lp9,Lp11

ATOMS	Theta	TZero	KB	EB	
O-Si-O	109.500	109.5000	0.5000	0.0000	O(2)-Si(1)-O(3)
O-Si-O	109.500	109.5000	0.5000	0.0000	O(2)-Si(1)-O(5)
O-Si-H	109.500	109.5000	0.5000	0.0000	O(2)-Si(1)-H(7)
O-Si-O	109.500	109.5000	0.5000	0.0000	O(3)-Si(1)-O(5)
O-Si-H	109.500	109.5000	0.5000	0.0000	O(3)-Si(1)-H(7)
O-Si-H	109.327	109.5000	0.5000	0.0003	O(5)-Si(1)-H(7)
Na-O-Si	109.500	109.5000	0.5000	0.0000	Si(1)-O(3)-Na(4)
Na-O-Lp	109.500	109.5000	0.5000	0.0000	Na(4)-O(3)-Lp(8)
Na-O-Lp	109.500	109.5000	0.5000	0.0000	Na(4)-O(3)-Lp(9)
Si-O-Lp	109.500	109.5000	0.5000	0.0000	Si(1)-O(3)-Lp(8)
Si-O-Lp	109.500	109.5000	0.5000	0.0000	Si(1)-O(3)-Lp(9)
Lp-O-Lp	109.327	109.5000	0.5000	0.0003	Lp(8)-O(3)-Lp(9)
Na-O-Si	109.500	109.5000	0.5000	0.0000	Si(1)-O(5)-Na(6)

Na-O-Lp	109.500	109.5000	0.5000	0.0000	Na(6)-O(5-Lp(10)
Na-O-Lp	109.500	109.5000	0.5000	0.0000	Na(6)-O(5-Lp(11)
Si-O-Lp	109.500	109.5000	0.5000	0.0000	Si(1)-O(5)-Lp(10)
Si-O-Lp	109.500	109.5000	0.5000	0.0000	Si(1)-O(5)-Lp(11)
Lp-O-Lp	109.327	109.5000	0.5000	0.0003	Lp(10)-O5-Lp(11)

ATOMS	Omega	V1	V2	V3	Et
O-Si-O-Na	59.929	0.0000	0.0000	0.0000	0.0000
O(2)-Si(1)-O(3)-Na(4)					
O-Si-O-Lp	-60.141	0.0000	0.0000	0.0000	0.0000
O(2)-Si(1)-O(3)-Lp(8)					
O-Si-O-Lp	180.000	0.0000	0.0000	0.0000	0.0000
O(2)-Si(1)-O(3)-Lp(9)					
O-Si-O-Na	180.000	0.0000	0.0000	0.0000	0.0000
O(5)-Si(1)-O(3)-Na(4)					
O-Si-O-Lp	59.929	0.0000	0.0000	0.0000	0.0000
O(5)-Si(1)-O(3)-Lp(8)					
O-Si-O-Lp	-59.929	0.0000	0.0000	0.0000	0.0000
O(5)-Si(1)-O(3)-Lp(9)					
H-Si-O-Na	-60.141	0.0000	0.0000	0.0000	0.0000
H(7)-Si(1)-O(3)-Na(4)					
H-Si-O-Lp	179.788	0.0000	0.0000	0.0000	0.0000
H(7)-Si(1)-O(3)-Lp(8)					
H-Si-O-Lp	59.929	0.0000	0.0000	0.0000	0.0000
H(7)-Si(1)-O(3)-Lp(9)					
O-Si-O-Na	-179.929	0.0000	0.0000	0.0000	0.0000
O(2)-Si(1)-O(5)-Na(6)					
O-Si-O-Lp	60.000	0.0000	0.0000	0.0000	0.0000
O(2)-Si(1)-O(5)-Lp(10)					
O-Si-O-Lp	-59.859	0.0000	0.0000	0.0000	0.0000
O(2)-Si(1)-O(5)-Lp(11)					
O-Si-O-Na	60.000	0.0000	0.0000	0.0000	0.0000
O(3)-Si(1)-O(5)-Na(6)					

Atoms	Charge1	Charge2	R	EC	
Na-Na	1.000	1.000	5.5814	39.662	Na(4),Na(6)
The steric energy for frame 1: 38.852 kcal/mole					

Extended Huckel Charge

Si 1.175	Si(1)
O -0.662	O(2)
O -0.574	O(3)
Na 0.764	Na(4)
O -0.548	O(5)
Na 0.783	Na(6)
H 0.063	H(7)

Dari hasil optimasi MM2 terhadap molekul, energy steric molekul Na_2SiO_3 adalah : 38.852 kcal/mole. Jarak antara atom Si(1)-O(5) adalah 1,626 °A dan 1,626 °A, atom Si(1)- O(3) adalah 1.626 °A dan 1.626 °A, atom Si(1)-O(2) adalah 1.512 °A, O(5)-Na(6) adalah 2.180 °A dan jarak antara atom O(3)-Na(4) adalah 2.180 °A. Massa atom Si adalah 28.086 gram/mol, Na adalah 22.990 gram/mol, dan O adalah 15.999 gram/mol.

4. Jari- jari Atom

Atom	Jari- Jari
Natrium	186 pm
Silikon	111 pm
Oksigen	60 pm

Tabel 2. Jari- jari atom penyusun Na_2SiO_3

5. Jari-jari Molekul

Gambar 5. Jarak antar atom pada molekul Na_2SiO_3

Jarak antar atom pada molekul Na_2SiO_3

Atoms	Actual/°A	Optimal/°A
Si(1)-O(5)	1.626	1.626
Si(1)-O(3)	1.626	1.626
Si(1)-O(2)	1.512	
O(5)-Na(6)	2.180	
O(3)-Na(4)	2.180	

Jarak antara atom Si(1)-O(5) adalah 1,626 °A dan 1,626 °A, atom Si(1)- O(3) adalah 1.626 °A dan 1.626 °A, atom Si(1)-O(2) adalah 1.512 °A, O(5)-Na(6) adalah 2.180 °A dan jarak antara atom O(3)-Na(4) adalah 2.180 °A. Massa atom Si adalah 28.086 gram/mol, Na adalah 22.990 gram/mol, dan O adalah 15.999 gram/mol⁽¹⁰⁰⁾.

6. Sifat- Sifat Termodinamika

Termokimia	
Kapasitas kalor (C)	111,8 J/(mol·K)
Entropi molar standar (S°)	113,71 J/(mol·K)
Entalpi pembentukan standar ($\Delta_f H^\circ$)	-1561,43 kJ/mol
Energi bebas Gibbs($\Delta_f G$)	-1427 kJ/mol

Tabel 3. Sifat Termokimia Natrium Silikat^(94; 101-103)

7. Gerak Molekul

Sebelum mengetahui bagaimana kekuatan hantaran dari molekul Natrium Silikat, terlebih dahulu mengetahui bagaimana pergerakan ion dari kation dan anion yang menyusun senyawa Natrium silikat⁽¹⁰⁰⁾. Kation disini yaitu Na^+ dan anionnya yaitu SiO_3^{2-} ⁽¹⁰⁴⁻¹⁰⁷⁾.. Setiap ion mempunyai laju yang berbeda-beda⁽¹⁰⁸⁾. Penyebab ion bergerak inilah memiliki konduktivitas molar yang berbeda, serta sebab konduktivitas molar elektrolit kuat berkurang dengan akar konsentrasi⁽¹⁰⁹⁾.

Ion	Mobilitas ionik ($10^{-8} \text{m}^2 \text{s}^{-1} \text{V}^{-1}$)
K+	7,62
Na+	5,19
Cl-	7,91
NO ₃ ⁻	7,40
F	5,70

Tabel 4. Mobillitas ion dalam air pada suhu 298 K⁽¹¹⁰⁾

Faktor-faktor yang mempengaruhi kecepatan ion :

1. Berat dan muatan ion, semakin ringan ion tiap satuan muatan maka semakin cepat ion bergerak⁽¹¹¹⁾.
2. Adanya hidrasi, semakin banyak molekul air yang mengerumuni ion maka semakin lambat gerakan ion⁽¹¹²⁾.
3. Orientasi atmosfer pelarut disekitar ion⁽¹¹³⁾.
4. Gaya tarik antara ion, semakin besar gaya tarik maka semakin lambat gerakan ion⁽¹¹⁴⁾.
5. Temperatur, semakin tinggi temperatur maka semakin cepat gerakan ion^(115; 116).
6. Viskositas, semakin besar viskositas maka semakin lambat gerakan ion.⁽¹⁰⁶⁾

Harga mobilitas ion mempengaruhi nilai konduktivitas dari suatu senyawa, semakin besar tingkat mobilitas ion dalam larutan maka semakin besar pula pengaruhnya konduktivitas ion dalam hal ini konduktivitas ion dalam senyawa Natrium Silikat.

8. Viskositas

Viskositas merupakan suatu pengukuran dari ketahanan atau kekentalan fluida yang diubah baik dengan tekanan maupun tegangan(117-119). Dalam kasus ini, metode ini lebih disukai, mereaksikan bahan kimia dengan larutan silikat(120-122). Hal ini menyebabkan penundaan pengerasan terjadi. Larutan gel yang tertunda, atau bahan kimia memadat pada waktu yang ditentukan(123-126). Larutan ini dapat bervariasi untuk konsentrasi, viskositas, dan waktu gel untuk padat^(4; 127-129). Dimana kegunaan dari larutan silikat ini sebagai perekat⁽¹³⁰⁾.

Grade	%Na ₂ O	&SiO ₂	%H ₂ O	Weight Rasio SiO ₂ / Na ₂ O	Gravity °Be	Viscosity CPS
40	9.1	29.3	61.6	3.22	41.5	200
40 Clear	9.1	29.3	61.6	3.22	41.5	200
42	9.3	30.0	60.7	3.22	42.5	400
JW	10.6	26.9	62.5	2.54	42.0	65
Clear						
JW-25	10.6	26.9	62.5	2.54	42.0	65
47	11.2	31.8	57.0	2.84	47.0	650
49 FG	12.4	32.0	55.6	2.58	49.0	600
52	13.9	33.4	52.7	2.40	52.0	1800
50	14.7	29.4	55.9	2.00	50.0	340
WD-43	13.3	23.9	62.8	1.80	43.8	60
30 Clear	10.6	27.0	62.4	2.55	42.3	65
20 Clear	8.9	28.9	62.8	3.25	41.04	175

Gravity and Viscosity Values at 20°C

Tabel 5. Data Percobaan Berbagai Spesifikasi Larutan Silikat^(131; 132)

Perhitungan viskositas :

9. Daya Hanyut

Jika dua buah elektroda yang terpisah dengan jarak l berada pada selisih potensial⁽¹³³⁾ ($\Delta\phi$), maka ion dalam larutan diantara kedua elektroda tersebut akan mengalami medan listrik (E) sebesar :

$$E = \frac{\Delta\phi}{l} \dots\dots\dots(1) \quad (134; 135)$$

Untuk ion (muatan ion) mengalami gaya sebesar :

$$F = zeE = \frac{ze\Delta\phi}{l} \dots\dots\dots(2) \quad (135-138)$$

Kation menuju elektroda negative, dan anion menuju elektroda positif. Namun saat ion bergerak melalui pelarut maka ion akan mengalami gaya gesekan yang akan memperlambat muatannya yang sebanding dengan kecepatan⁽¹³⁹⁻¹⁴²⁾. Maka dapat disimpulkan gaya perlambatan ini sebagai:

$$F' = fs \qquad f = 6\pi\eta\alpha \dots\dots\dots(3) \quad (143)$$

Kedua gaya ini bekerja dalam arah yang berlawanan dan ion mencapai kecepatan akhir, yaitu kecepatan hanyut ion (s), jika gaya mempercepat F diimbangi oleh gaya perlambatan F' ^(139; 141; 143-145). Gaya neto menjadi nol ($F=F'$) jika :

$$s = \frac{zeE}{f} \dots\dots\dots(4)$$

Karena kecepatan hanyut mengatur laju transportasi ion⁽¹⁴⁶⁻¹⁴⁸⁾. Maka dapat dihasilkan konduktivitas berkurang dengan bertambahnya viskositas pelarut ukuran ion. Contohnya, Konduktivitas molar ion logam alkali bertambah dari Li^+ ke Cs^+ , walaupun jari-jari ionnya bertambah. Radius α dalam rumus stokes adalah radius hidrodinamik ion⁽¹⁴⁹⁻¹⁵²⁾, yaitu radius efektif dalam larutan dengan memperhitungkan molekul H_2O yang dibawa dalam bola hidrasinya⁽¹⁵³⁻¹⁵⁵⁾. Ion kecil menyebabkan medan listrik lebih kuat dari pada ion besar, sehingga ion kecil lebih terlarut secara ekstensif dari ion besar^(146; 148; 156-158). Jadi, ion dengan radius kecil dapat mempunyai radius hidrodinamik besar, karena ion itu menyeret banyak molekul pelarut melalui larutan itu saat bermigrasi⁽¹⁵⁹⁻¹⁶²⁾.

$$U = \frac{x}{t \left(\frac{dE}{dx} \right)} \dots\dots\dots(5) \quad (163; 164)$$

X = jarak (m)

t = waktu (dt)

$\left(\frac{dE}{dx} \right)$ = kekuatan medan (volt.m⁻¹)

$$E = \frac{dE}{dx} \dots\dots\dots(6)$$

Maka,

$$U = \frac{\lambda_m}{zF} \dots\dots\dots(7)$$

Z = valensi kation

F = Faraday

Karena kecepatan hanyut mengatur laju transportasi ion, maka dapat diharapkan konduktivitas akan berkurang dengan bertambahnya viskositas pelarut akan ukuran ion.

Perhitungan kecepatan hanyut :

Pemisalan Jika potensial Na_2SiO_3 3,61 V dan jarak antara elektroda adalah 1,5 cm, maka kecepatan hanyutnya dapat dihitung sebagai berikut :

$$E = \frac{\Delta\phi}{l}$$

$$E = \frac{3.61 \text{ V}}{1,5 \text{ cm}} = 2,407 \text{ V/cm}$$

Jadi kecepatan hanyut Na_2SiO_3 adalah 2,407 V/cm

10. Hantaran

Kondutivitas atau hantaran merupakan pengukuran dasar untuk mempelajari gerakan ion, konduktivitas atau daya hantar listrik adalah kekuatan seberapa kuat larutan dapat menghantarkan listrik. Hantaran merupakan kebalikan dari hambatan listrik. Menurut percobaan yang telah dilakukan didapat grafik seperti di bawah ini:

Grafik 1. Pengaruh *electric field* terhadap luas permukaan padatan silika^(165; 166)

Dari data yang didapat, dapat disimpulkan bahwa luas permukaan partikel silika cenderung meningkat dengan meningkatnya *electric field* yang diberikan. Semakin tinggi *electric field* yang digunakan dalam kondisi operasi berikut, maka akan semakin optimal migrasi partikel silika di dalam larutan untuk membentuk partikel yang padat dan homogen^(79; 167; 168). Perhitungan nilai konduktivitas didapatkan dengan menggunakan Hukum Fourier. Dari grafik 1 dapat dilihat bahwa semakin besar gradien perubahan suhu, maka nilai konduktivitas akan semakin kecil⁽¹⁶⁹⁻¹⁷³⁾. Nilai konduktivitas panas yang dihasilkan berkisar antara 1,89 W/mK - 3,61 W/mK^(79; 165; 166; 174)

Perhitungan Konduktivitas:

Diketahui untuk persen massa 1,5% dan konduktivitas listrik 4,0, maka konduktivitas molar dapat ditentukan dengan persamaan :

$$\Lambda = \frac{\kappa}{c}$$

$$\Lambda = \frac{4,0}{1,5}$$

$$\Lambda = 2,667 \text{ S cm}^2 \text{ \% massa}$$

11. Besaran KF3

1. Bilangan Transport

Bilangan transport merupakan fraksi dari arus total yang dibawa oleh ion jenis tertentu. Untuk larutan dengan 2 jenis ion (178-181), bilangan dengan I^+ merupakan arus kation, I adalah arus total yang melalui larutan, dan I^- adalah arus anion. Dapat diasumsikan sebagai:

$$I^+ + I^- = I \quad (179-183)$$

Bilangan transport merupakan pembatas t^0 , namun untuk limit konsentrasi nol dari larutan elektrolit itu (184-188). Arus yang berasal dari setiap jenis ion berhubungan dengan mobilitas ion. Jadi hubungan antara t^0 dan u yaitu:

$$t^0 = \frac{z v u}{\sum_i z v u_i} \dots \dots \dots (9)$$

Untuk elektrolit simetris merupakan bilangan muatan untuk kedua ion sama, maka persamaan diatas dapat disederhanakan (186; 188-190):

$$t^0 = \frac{u}{\sum_i u_i} \dots \dots \dots (10)$$

Hubungan antara konduktivitas ion dengan mobilitas ion (191-194):

$$t^0 = \frac{v \lambda}{\sum_i v_i \lambda_i} = \frac{v \lambda}{\Lambda_m^0} \dots \dots \dots (11)$$

Jadi untuk setiap jenis ion (194-197):

$$v \lambda = t^0 \Lambda_m^0 \dots \dots \dots (12)$$

2) Hubungan Einstein

Hukum Fick untuk fluks partikel dalam mol molekul per satuan luas per satuan waktu adalah (198-202):

$$J = -D \frac{dc}{dx} \quad (13)$$

Dengan D merupakan koefisien difusi dan dc/dx merupakan kemiringan dari konsentrasi molar. Fluks partikel berhubungan dengan kecepatan hanyut (198; 200; 201; 203; 204), dengan:

$$J = s c \quad (14)$$

Hubungan ini merupakan kelanjutan dari argument yang sudah kita gunakan beberapa kali sebelumnya. Jadi, semua partikel dalam jarak $s \Delta t$ A , dapat melewati jendela dengan luas A dalam selang waktu Δt (205-209). Dengan demikian, jumlah mol dapat lewat dalam selang waktu itu adalah: $s \Delta t \times c$, sehingga:

$$s c = -D \frac{dc}{dx} \quad (15)$$

Jika sekarang kita menyatakan dc/dx dalam ϵ , menggunakan persamaan 15, maka kita memperoleh:

$$s = -\frac{D}{c} \frac{dc}{dx} = \frac{D}{RT} \times \epsilon \quad (16)$$

Terdapat satu kasus ketika kita sudah mengetahui kecepatan hanyut dan gaya efektif yang bekerja pada partikel: ion dalam larutan mempunyai kecepatan hanyut $s = \mu E$ jika ion itu mengalami gaya $e z E$, dan $z F E$ per mol, dari medan listrik dengan kuat medan E (210-212). Jadi penggantian nilai tersebut ke dalam persamaan dia atas, menghasilkan:

$$\mu E = \frac{D}{RT} \times z F E \text{ atau } \mu = \frac{z F D}{RT} \dots \dots \dots (17)$$

$$D = \frac{\mu R T}{z F} \dots \dots \dots (18)$$

Persamaan ini tertata ulang menjadi hasil yang sangat penting, yang dikenal sebagai **hubungan Einstein**, antara oefisien difusi dengan mobilitas ion (213-217)

12. Energi Stability

Energi stabilitas yaitu energi dalam keadaan termodinamika pada suatu molekul yang mengalami kesetimbangan kimia dengan lingkungannya (218-222). Berikut optimasi energi stability dari molekul Natrium Silikat yang ditinjau menggunakan Chem Ultra 3D:

-----MM2 Dynamics-----

Warning: The number of ligands attached does not match the geometry of Na Na(6)

Warning: The number of ligands attached does not match the geometry of Na Na(4)

Warning: Some parameters are guessed (Quality = 1).

Time	Total Energy	Potential Energy	Temperature
0.010	38.911 ±0.037	38.845 ±0.012	2.02 ±1.32
1.000	44.593 ±0.023	39.602 ±0.408	152.21 ±13.09
2.000	49.471 ±0.019	41.910 ±0.468	230.60 ±14.25
3.000	52.169 ±0.058	46.720 ±0.670	166.18 ±18.96
4.000	52.697 ±0.131	40.400 ±0.740	375.04 ±20.68
5.000	51.583 ±0.079	44.595 ±0.706	213.11 ±21.46
6.000	53.271 ±0.073	38.700 ±0.933	444.39 ±28.52
7.000	52.359 ±0.085	39.941 ±0.517	378.72 ±17.27
8.000	52.800 ±0.064	43.039 ±0.898	297.69 ±27.81
9.000	52.271 ±0.098	41.920 ±0.691	315.70 ±21.24
10.000	52.582 ±0.069	41.473 ±0.638	338.80 ±19.18
11.000	51.549 ±0.095	44.132 ±0.427	226.21 ±12.63
12.000	52.494 ±0.089	41.342 ±0.533	340.14 ±16.40
13.000	52.630 ±0.103	40.107 ±0.478	381.92 ±12.74
14.000	52.709 ±0.084	43.697 ±0.408	274.84 ±13.40
15.000	53.182 ±0.164	43.567 ±1.338	293.22 ±39.74
16.000	53.416 ±0.063	45.441 ±0.659	243.21 ±18.44
17.000	53.967 ±0.151	40.753 ±0.457	402.99 ±13.43
18.000	52.863 ±0.090	43.376 ±0.995	289.34 ±31.81
19.000	52.415 ±0.125	41.878 ±0.772	321.36 ±20.78
20.000	52.517 ±0.170	45.949 ±0.972	200.33 ±27.87

4. Kesimpulan

Natrium Silikat merupakan senyawa dengan rumus senyawa Na_2SiO_3 . Natrium silikat mempunyai banyak kegunaan dengan mensintesisnya dari pasir kuarsa (pasir silica) dari limbah industry yang mempunyai nilai tinggi. Atom-atom penyusun natrium silikat yaitu, Na, Si, dan 2O. Untuk mengetahui bentuk molekul menggunakan pemodelan komputasi dengan software ChemOffice 15.0. Natrium Silikat memiliki konduktivitas, gerakan ion yang lumayan tinggi, dan viskositas yang beragam bergantung pada jenisnya.

REFERENSI

1. Nematollahi MJ, Clark MJR, Ebrahimi P, Ebrahimi M. 2018. Preliminary assessment of groundwater hydrogeochemistry within Gilan, a northern province of Iran. *Environmental monitoring and assessment* 190:242
2. Wickramarathna S, Balasooriya S, Diyabalanage S, Chandrajith R. 2017. Tracing environmental aetiological factors of chronic kidney diseases in the dry zone of Sri Lanka-A hydrogeochemical and isotope approach. *Journal of trace elements in medicine and biology : organ of the Society for Minerals and Trace Elements* 44:298-306
3. Kajthunyakarn W, Sakloetsakun D, Pongjanyakul T. 2018. Sodium caseinate-magnesium aluminum silicate nanocomposite films for modified-release tablets. *Materials science & engineering. C, Materials for biological applications* 92:827-39

4. Huang B, Liu M, Long Z, Shen Y, Zhou C. 2017. Effects of halloysite nanotubes on physical properties and cytocompatibility of alginate composite hydrogels. *Materials science & engineering. C, Materials for biological applications* 70:303-10
5. Kearney K, Seo G, Matsushima T, Adachi C, Ertekin E, Rockett AA. 2018. Computational Analysis of the Interplay between Deep Level Traps and Perovskite Solar Cell Efficiency. *Journal of the American Chemical Society*
6. Zhang Q, Zhang N, Kang L, Hu G, Yan X, et al. 2018. Technology Development for Simultaneous Wearable Monitoring of Cerebral Hemodynamics and Blood Pressure. *IEEE journal of biomedical and health informatics*
7. Neschen S, Wu M, Fuchs C, Kondofersky I, Theis FJ, et al. 2018. Impact of Brain Fatty Acid Signaling on Peripheral Insulin Action in Mice. *Experimental and clinical endocrinology & diabetes : official journal, German Society of Endocrinology [and] German Diabetes Association*
8. Nalaparaju A, Babarao R, Zhao XS, Jiang JW. 2009. Atomistic insight into adsorption, mobility, and vibration of water in ion-exchanged zeolite-like metal-organic frameworks. *ACS nano* 3:2563-72
9. Liberelle B, Giasson S. 2008. Friction and normal interaction forces between irreversibly attached weakly charged polymer brushes. *Langmuir : the ACS journal of surfaces and colloids* 24:1550-9
10. Yu Z, Li B, Chu J, Zhang P. 2018. Silica in situ enhanced PVA/chitosan biodegradable films for food packages. *Carbohydrate polymers* 184:214-20
11. Heuss SC, Schwartz BJ, Schneeberger AR. 2018. Second Opinions in Psychiatry: A Review. *Journal of psychiatric practice* 24:434-42
12. Qing J, Chen A, Zhao N. 2018. Quantifying the protein-protein association rate in polymer solutions: crowding-induced diffusion and energy modifications. *Physical chemistry chemical physics : PCCP*
13. Valiei A, Okshevsky M, Lin N, Tufenkji N. 2018. Anodized Aluminum with Nanoholes Impregnated with Quaternary Ammonium Compounds Can Kill Pathogenic Bacteria Within Seconds of Contact. *ACS applied materials & interfaces*
14. Noje C, Bembea MM, Nelson McMillan KL, Brunetti MA, Bernier ML, et al. 2018. A National Survey on Interhospital Transport of Children in Cardiac Arrest. *Pediatric critical care medicine : a journal of the Society of Critical Care Medicine and the World Federation of Pediatric Intensive and Critical Care Societies*
15. Chen J, Jiang H, Li F, Hu B, Wang Y, et al. 2018. Computational insight into dengue virus NS2B-NS3 protease inhibition: A combined ligand- and structure-based approach. *Computational biology and chemistry* 77:261-71
16. IJesione K, Kostur M. 2018. Low-density lipoprotein accumulation within the right coronary artery walls for physiological and hypertension conditions. *Bio Systems*
17. Liza, Y. M., Yasin, R. C., Maidani, S. S., & Zainul, R. (2018, September 29). SOL GEL : PRINCIPLE AND TECHNIQUE (A REVIEW). <https://doi.org/10.31227/osf.io/2cuh8>
18. Zainul, R. (2016, November 19). Effect of Temperature and Particle Motion against the ability of ZnO Semiconductor Photocatalyst in Humic Acid. <https://doi.org/10.31227/osf.io/wnygb>
19. Dinata, A. A., Rosyadi, A. M., Hamid, S., & Zainul, R. (2018, August 31). A Review CHEMICAL VAPOR DEPOSITION : PROCESS AND APPLICATION. <https://doi.org/10.31227/osf.io/yfeau>
20. Putri, D. F., Ritonga, H. M., Murdiati, V., & Zainul, R. (2018, August 31). A REVIEW WHAT IS HYDROTHERMAL ?. <https://doi.org/10.31227/osf.io/dm56c>
21. Awalliyah, A., Ikhwan, H., Nugiasari, V., & Zainul, R. (2018, August 31). A REVIEW PRINSIP DASAR MILLING DALAM SINTESIS MATERIAL. <https://doi.org/10.31227/osf.io/9xsqe>
22. Candani, D., Ulfah, M., Noviana, W., & Zainul, R. (2018, September 1). A Review Pemanfaatan Teknologi Sonikasi. <https://doi.org/10.31227/osf.io/uxknv>
23. Fatimah, P., Jumalia, R., Novianti, E. R., & Zainul, R. (2018, August 31). A REVIEW Teknik Blended : Prinsip dan Dasar-Dasar. <https://doi.org/10.31227/osf.io/tm2w4>

24. Zainul, R., Oktavia, B., Dewata, I., & efendi, j. (2017, February 4). Studi Dinamika Molekular dan Kinetika Reaksi pada Pembelahan Molekul Air untuk Produksi Gas Hidrogen. <https://doi.org/10.31227/osf.io/876s3>
25. Sen M, Dana K, Das N. 2018. Development of LTA zeolite membrane from clay by sonication assisted method at room temperature for H₂-CO₂ and CO₂-CH₄ separation. *Ultrasonics sonochemistry* 48:299-310
26. Durgalakshmi D, Ajay Rakesh R, Kesavan M, Ganapathy S, Ajithkumar TG, et al. 2018. Highly reactive crystalline-phase-embedded strontium-bioactive nanorods for multimodal bioactive applications. *Biomaterials science* 6:1764-76
27. Jugdaohsingh R, Kessler K, Messner B, Stoiber M, Pedro LD, et al. 2015. Dietary Silicon Deficiency Does Not Exacerbate Diet-Induced Fatty Lesions in Female ApoE Knockout Mice. *The Journal of nutrition* 145:1498-506
28. Abinaya Sindu P, Kolanthai E, Suganthi RV, Thanigai Arul K, Manikandan E, et al. 2017. Green synthesis of Si-incorporated hydroxyapatite using sodium metasilicate as silicon precursor and in vitro antibiotic release studies. *Journal of photochemistry and photobiology. B, Biology* 175:163-72
29. Lee MG, Park JW, Kam SK, Lee CH. 2018. Synthesis of Na-A zeolite from Jeju Island scoria using fusion/hydrothermal method. *Chemosphere* 207:203-8
30. Manning JRH, Routoula E, Patwardhan SV. 2018. Preparation of Functional Silica Using a Bioinspired Method. *Journal of visualized experiments : JoVE*
31. Smail-Faugeron V, Glenney AM, Courson F, Durieux P, Muller-Bolla M, Fron Chabouis H. 2018. Pulp treatment for extensive decay in primary teeth. *The Cochrane database of systematic reviews* 5:CD003220
32. Gregg RW, Sarkar SN, Shoemaker JE. 2018. Mathematical Modeling of the cGAS Pathway Reveals Robustness of DNA Sensing to TREX1 Feedback. *Journal of theoretical biology*
33. Li JK, Kaya M, Kerkhof PLM. 2018. Quantitative cardiology and computer modeling analysis of heart failure in systole and in diastole. *Computers in biology and medicine* 103:252-61
34. Gopalan G, Prabha B, Joe A, Reshmitha TR, Sherin DR, et al. 2018. Screening of Musa balbisiana Colla. seeds for antidiabetic properties and isolation of apiforol, a potential lead, with antidiabetic activity. *Journal of the science of food and agriculture*
35. Gluth S, Spektor MS, Rieskamp J. 2018. Value-based attentional capture affects multi-alternative decision making. *eLife* 7
36. Keskin C, Sariyilmaz E, Kele SA. 2018. The effect of bleaching agents on the compressive strength of calcium silicate-based materials. *Australian endodontic journal : the journal of the Australian Society of Endodontology Inc*
37. Martins AD, Martins JPR, Batista LA, Dias GMG, Almeida MO, et al. 2018. Morpho-physiological changes in Billbergia zebrina due to the use of silicates in vitro. *Anais da Academia Brasileira de Ciencias*
38. Hoy SM. 2018. Sodium Zirconium Cyclosilicate: A Review in Hyperkalaemia. *Drugs* 78:1605-13
39. Manavitehrani I, Fathi A, Schindeler A, Dehghani F. 2018. Sustained Protein Release from a Core-Shell Drug Carrier System Comprised of Mesoporous Nanoparticles and an Injectable Hydrogel. *Macromolecular bioscience*:e1800201
40. Naguib IA, Abdelaleem EA, Hassan ES, Ali NW. 2018. HPTLC method for Simultaneous Determination of Norfloxacin and Tinidazole in presence of Tinidazole Impurity. *Journal of chromatographic science*
41. Liang J, Wei D, Lin N, Zhu Y, Li X, et al. 2014. Low temperature chemical reduction of fusional sodium metasilicate nonahydrate into a honeycomb porous silicon nanostructure. *Chemical communications* 50:6856-9
42. Pyatina T, Sugama T, Moon J, James S. 2016. Effect of Tartaric Acid on Hydration of a Sodium-Metasilicate-Activated Blend of Calcium Aluminate Cement and Fly Ash F. *Materials* 9

43. Zainul, R., Alif, A., Aziz, H., Arief, S., & s. (2015, October 22). Photoelectrosplitting Water Mechanism at Carbon Electrode Surface using Indoor lights. <https://doi.org/10.31227/osf.io/vcxq8>
44. Zainul, R., Alif, A., Aziz, H., Arief, S., & s. (2015, October 22). Photoelectrosplitting Water Mechanism at Carbon Electrode Surface using Indoor lights. <https://doi.org/10.31227/osf.io/vcxq8>
45. M., Yani, S. R., & Zainul, R. (2017, September 4). Aktivasi Tanah Napa dan Pengaruhnya Terhadap Adsorpsi Ion Timbal (II)/ Pb²⁺. <https://doi.org/10.31227/osf.io/ps523>
46. P, O. M., A, L. G., S, A. Y. M., & Zainul, R. (2018, September 1). A Review Grinding : Teknik dan Prinsip Dasar pada Pengolahan Material. <https://doi.org/10.31227/osf.io/trv4q>
47. H., Sanjaya, H., & Zainul, R. (2016, August 30). Synthesis and Electrical Properties of ZnO-ITO and Al-ITO thin Film by Spin Coating Technique Through Sol Gel Process. <https://doi.org/10.31227/osf.io/unrt4>
48. M., Sanjaya, H., & Zainul, R. (2015, December 30). Characterization of napa soil and adsorption of Pb (II) from aqueous solutions using on column method. <https://doi.org/10.31227/osf.io/t8fh9>
49. chaidir, z., Fadjria, N., A., & Zainul, R. (2016, December 5). ISOLATION AND MOLECULAR IDENTIFICATION OF FRESHWATER MICROALGAE IN MANINJAU LAKE WEST SUMATERA. <https://doi.org/10.31227/osf.io/nbcuf>
50. Rioland G, Dutournie P, Faye D, Daou TJ, Patarin J. 2016. Prediction of the mechanical properties of zeolite pellets for aerospace molecular decontamination applications. *Beilstein journal of nanotechnology* 7:1761-71
51. Bassil BS, Haider A, Ibrahim M, Mougharbel AS, Bhattacharya S, et al. 2018. 15-Copper(ii)-containing 36-tungsto-4-silicates(iv) [Cu₁₅O₂(OH)₁₀X(A- α -SiW₉O₃₄)₄](25-) (X = Cl, Br): synthesis, structure, magnetic properties, and electrocatalytic CO₂ reduction. *Dalton transactions* 47:12439-48
52. Nunu WN, Kativhu T, Moyo P. 2018. An evaluation of the effectiveness of the Behaviour Based Safety Initiative card system at a cement manufacturing company in Zimbabwe. *Safety and health at work* 9:308-13
53. Yu Z, Hu L, Lo IMC. 2018. Transport of the arsenic (As)-loaded nano zero-valent iron in groundwater-saturated sand columns: Roles of surface modification and As loading. *Chemosphere* 216:428-36
54. Wang AO, Ptacek CJ, Blowes DW, Gibson BD, Landis RC, et al. 2018. Application of hardwood biochar as a reactive capping mat to stabilize mercury derived from contaminated floodplain soil and riverbank sediments. *The Science of the total environment* 652:549-61
55. Ji X, Liu Y, Zhang J, Huang D, Zhou P, Zheng Z. 2018. Development of model simulation based on BioWin and dynamic analyses on advanced nitrate nitrogen removal in deep bed denitrification filter. *Bioprocess and biosystems engineering*
56. Brusseau ML, Yan N, Van Glubt S, Wang Y, Chen W, et al. 2018. Comprehensive retention model for PFAS transport in subsurface systems. *Water research* 148:41-50
57. Acharya P, Sreekesh S, Kulshrestha U, Gupta G. 2018. Characterisation of emission from open-field burning of crop residue during harvesting period in north-west India. *Environmental monitoring and assessment* 190:663
58. Bird DL, Groffman PM, Salice C, Moore J. 2018. Steady-State Land Cover but Non-Steady-State Major Ion Chemistry in Urban Streams. *Environmental science & technology*
59. Duarte MAH, Marciano MA, Vivan RR, Tanomaru Filho M, Tanomaru JMG, Camilleri J. 2018. Tricalcium silicate-based cements: properties and modifications. *Brazilian oral research* 32:e70
60. Lee S, Kumari N, Jeon KW, Kumar A, Kumar S, et al. 2018. Monofacet-Selective Cavitation within Solid-State Silica-Nanoconfinement towards Janus Iron Oxide Nanocube. *Journal of the American Chemical Society*
61. Mao M, Gao T, Hou S, Wang C. 2018. A critical review of cathodes for rechargeable Mg batteries. *Chemical Society reviews*

62. Yang L, Wen T, Wang L, Miki T, Bai H, et al. 2018. The stability of the compounds formed in the process of removal Pb(II), Cu(II) and Cd(II) by steelmaking slag in an acidic aqueous solution. *Journal of environmental management* 231:41-8
63. Peng L, Dai H, Wu Y, Dai Z, Li X, Lu X. 2018. Performance and adsorption mechanism of a magnetic calcium silicate hydrate composite for phosphate removal and recovery. *Water science and technology : a journal of the International Association on Water Pollution Research* 2017:578-91
64. Sasaki K, Hayashi Y, Toshiyuki K, Guo B. 2018. Simultaneous immobilization of borate, arsenate, and silicate from geothermal water derived from mining activity by co-precipitation with hydroxyapatite. *Chemosphere* 207:139-46
65. Torres FFE, Guerreiro-Tanomaru JM, Bosso-Martelo R, Chavez-Andrade GM, Tanomaru Filho M. 2018. Solubility, porosity and fluid uptake of calcium silicate-based cements. *Journal of applied oral science : revista FOB* 26:e20170465
66. Wang C, Li J, Sun X, Wang L, Sun X. 2009. Evaluation of zeolites synthesized from fly ash as potential adsorbents for wastewater containing heavy metals. *Journal of environmental sciences* 21:127-36
67. Shah MH, Biradar SV, Paradkar AR. 2006. Spray dried glyceryl monooleate-magnesium trisilicate dry powder as cubic phase precursor. *International journal of pharmaceuticals* 323:18-26
68. chaidir, z., Zainul, R., Nurakhbari, D., & Salim, M. (2016, September 24). Optimization of Spirulina Platensis Culture for Antioxidant Production. <https://doi.org/10.17605/OSF.IO/FD6E4>
69. Zainul R, Oktavia B, Dewata I, Efendi J. Thermal and Surface Evaluation on The Process of Forming a Cu₂O/CuO Semiconductor Photocatalyst on a Thin Copper Plate. *Proc. IOP Conference Series: Materials Science and Engineering*, 2018, 335:012039: IOP Publishing
70. Zainul R, Alif A, Aziz H, Arief S, Dradjad S, Munaf E. 2015. Design of photovoltaic cell with copper oxide electrode by using indoor lights. *RESEARCH JOURNAL OF PHARMACEUTICAL BIOLOGICAL AND CHEMICAL SCIENCES* 6:353-61
71. Mawardi M, Deyundha D, Zainul R. Characterization of PCC Cement by Addition of Napa Soil from Subdistrict Sarilamak 50 Kota District as Alternative Additional Material for Semen Padang. *Proc. IOP Conference Series: Materials Science and Engineering*, 2018, 335:012034: IOP Publishing
72. Anhar A, Sumarmin R, Zainul R. 2016. Measurement of Glycemic Index of West Sumatera Local Rice Genotypes for Healthy Food Selection.
73. Zainul R, Dewata I. 2015. Determination of pH-BOD-COD and degradation in batang arau watersheds at Padang city.
74. Zainul R, Alif A, Aziz H, Arief S. 2015. DISAIN GEOMETRI REAKTOR FOTOSEL CAHAYA RUANG. *Jurnal Riset Kimia* 8:131
75. Zainul R, Alif A, Aziz H, Arief S, Darajat S. 2015. Modifikasi dan Karakteristik IV Sel Fotovoltaik Cu₂O/Cu-Gel Na₂SO₄ Melalui Iluminasi Lampu Neon. *EKSAKTA* 2:50
76. Anunziata OA, Gomez Costa MB, Sanchez RD. 2005. Preparation and characterization of polyaniline-containing Na-AlMCM-41 as composite material with semiconductor behavior. *Journal of colloid and interface science* 292:509-16
77. Alonso-Dominguez D, Pico MP, Alvarez-Serrano I, Lopez ML. 2018. New Fe₂O₃-Clay@C Nanocomposite Anodes for Li-Ion Batteries Obtained by Facile Hydrothermal Processes. *Nanomaterials* 8
78. Hesas RH, Baei MS, Rostami H, Gardy J, Hassanpour A. 2018. An investigation on the capability of magnetically separable Fe₃O₄/mordenite zeolite for refinery oily wastewater purification. *Journal of environmental management*
79. Appelt-Menzel A, Cubukova A, Metzger M. 2018. Establishment of a Human Blood-Brain Barrier Co-Culture Model Mimicking the Neurovascular Unit Using Induced Pluripotent Stem Cells. *Current protocols in stem cell biology*:e62

80. Ge Y, Bin D, Li C, Wei M, Chen Y, et al. 2018. Application of sodium silicate retards the apples softening by suppressing the activity of enzymes related to cell wall degradation. *Journal of the science of food and agriculture*
81. Shen ZY, Chen CY, Lee MT. 2019. Recovery of cutting fluids and silicon carbide from slurry waste. *Journal of hazardous materials* 362:115-23
82. Lander L, Tarascon JM, Yamada A. 2018. Sulfate-Based Cathode Materials for Li- and Na-Ion Batteries. *Chemical record* 18:1394-408
83. Honorio T, Brochard L, Vandamme M, Lebee A. 2018. Flexibility of nanolayers and stacks: implications in the nanostructuring of clays. *Soft matter* 14:7354-67
84. Martinez Blanes JM, Szyja BM, Romero-Sarria F, Centeno MA, Hensen EJ, et al. 2013. Multiple zeolite structures from one ionic liquid template. *Chemistry* 19:2122-30
85. Montazerolghaem M, Nystrom L, Engqvist H, Karlsson Ott M. 2015. Zebrafish: A possible tool to evaluate bioactive ions. *Acta biomaterialia* 19:10-4
86. Motta FL, Gaikwad R, Botha L, Soares JBP. 2018. Quantifying the effect of polyacrylamide dosage, Na(+) and Ca(2+) concentrations, and clay particle size on the flocculation of mature fine tailings with robust statistical methods. *Chemosphere* 208:263-72
87. Nazarian S, Majd A, Irian S, Najafi F, Ghahremaninejad F, et al. 2017. Comparison of silicon nanoparticles and silicate treatments in fenugreek. *Plant physiology and biochemistry : PPB* 115:25-33
88. Ding Y, Wang Y, Zheng X, Cheng W, Shi R, Feng R. 2017. Effects of foliar dressing of selenite and silicate alone or combined with different soil ameliorants on the accumulation of As and Cd and antioxidant system in Brassica campestris. *Ecotoxicology and environmental safety* 142:207-15
89. Hossein Nia B, Khorram S, Rezazadeh H, Safaiyan A, Tarighat-Esfanjani A. 2018. The Effects of Natural Clinoptilolite and Nano-Sized Clinoptilolite Supplementation on Glucose Levels and Oxidative Stress in Rats With Type 1 Diabetes. *Canadian journal of diabetes* 42:31-5
90. Wang J, Yao Z, Wang Y, Xia Q, Chu H, Jiang Z. 2017. Preparation of immobilized coating Fenton-like catalyst for high efficient degradation of phenol. *Environmental pollution* 224:552-8
91. Sahin K, Orhan C, Tuzcu M, Hayirli A, Komorowski JR, Sahin N. 2018. Effects of dietary supplementation of arginine-silicate-inositol complex on absorption and metabolism of calcium of laying hens. *PLoS one* 13:e0189329
92. Asgari F, Majd A, Jonoubi P, Najafi F. 2018. Effects of silicon nanoparticles on molecular, chemical, structural and ultrastructural characteristics of oat (*Avena sativa* L.). *Plant physiology and biochemistry : PPB* 127:152-60
93. Kobylak N, Abenavoli L, Falalyeyeva T, Beregova T. 2018. Efficacy of Probiotics and Smectite in Rats with Non-Alcoholic Fatty Liver Disease. *Annals of hepatology* 17:153-61
94. Khatamian M, Yavari A, Akbarzadeh A, Alizadeh E. 2017. Synthesis and characterization of MFI-type borosilicate zeolites and evaluation of their efficiency as drug delivery systems. *Materials science & engineering. C, Materials for biological applications* 78:1212-21
95. Meng Q, Chen H, Lin J, Lin Z, Sun J. 2017. Zeolite A synthesized from alkaline assisted pre-activated halloysite for efficient heavy metal removal in polluted river water and industrial wastewater. *Journal of environmental sciences* 56:254-62
96. Nagarpita MV, Roy P, Shruthi SB, Sailaja RRN. 2017. Synthesis and swelling characteristics of chitosan and CMC grafted sodium acrylate-co-acrylamide using modified nanoclay and examining its efficacy for removal of dyes. *International journal of biological macromolecules* 102:1226-40
97. Akiyama Y, Mizukami F, Kiyozumi Y, Maeda K, Izutsu H, Sakaguchi K. 1999. A Novel Layered Silicate with a Helical Morphology. *Angewandte Chemie* 38:1420-2
98. Lyu W, Jia H, Deng C, Saito K, Yamada S, Kato H. 2017. Zeolite-Containing Mixture Supplementation Ameliorated Dextran Sodium Sulfate-Induced Colitis in Mice by Suppressing the Inflammatory Bowel Disease Pathway and Improving Apoptosis in Colon Mucosa. *Nutrients* 9

99. Chen S, Yang Q, Brow RK, Liu K, Brow KA, et al. 2017. In vitro stimulation of vascular endothelial growth factor by borate-based glass fibers under dynamic flow conditions. *Materials science & engineering. C, Materials for biological applications* 73:447-55
100. Manoharan T, Laksmanan D, Mysamy K, Sivakumar P, Sircar A. 2018. Engineering properties of concrete with partial utilization of used foundry sand. *Waste management* 71:454-60
101. Hu B, Hui W. 2018. Lead recovery from waste CRT funnel glass by high-temperature melting process. *Journal of hazardous materials* 343:220-6
102. Kalaw ME, Culaba A, Hinode H, Kurniawan W, Gallardo S, Promentilla MA. 2016. Optimizing and Characterizing Geopolymers from Ternary Blend of Philippine Coal Fly Ash, Coal Bottom Ash and Rice Hull Ash. *Materials* 9
103. Huang H, Ning XC, Guo ZY, Guo D, Zhang ZQ, et al. 2017. [Cd() Ion Adsorption and Sealing onto SBA-15 Mesoporous Particles and the Related Potential on Cd() Polluted Soil Remediation]. *Huan jing ke xue= Huanjing kexue* 38:374-81
104. Jesudoss SK, Judith Vijaya J, Kaviyarasu K, Iyyappa Rajan P, Narayanan S, John Kennedy L. 2018. In-vitro anti-cancer activity of organic template-free hierarchical M (Cu, Ni)-modified ZSM-5 zeolites synthesized using silica source waste material. *Journal of photochemistry and photobiology. B, Biology* 186:178-88
105. Yongvanich N, Supanichwatn K, Penglan J, Triamnak N. 2018. Synthesis and Characterizations of (CoxMg(2-x))SiO(4) Forsterite Ceramic Pigments from Mirror Waste. *Materials* 11
106. Yang S, Wu P, Ye Q, Li W, Chen M, Zhu N. 2018. Efficient catalytic degradation of bisphenol A by novel Fe(0)- vermiculite composite in photo-Fenton system: Mechanism and effect of iron oxide shell. *Chemosphere* 208:335-42
107. Musyoka NM, Rambau KM, Manyala N, Ren J, Langmi HW, Mathe MK. 2018. Utilization of waste tyres pyrolysis oil vapour in the synthesis of Zeolite Templated Carbons (ZTCs) for hydrogen storage application. *Journal of environmental science and health. Part A, Toxic/hazardous substances & environmental engineering* 53:1022-8
108. Fang W, Jiang X, Luo H, Geng J. 2018. Synthesis of graphene/SiO2@polypyrrole nanocomposites and their application for Cr(VI) removal in aqueous solution. *Chemosphere* 197:594-602
109. Daoud W, Ebadi T, Fahimifar A. 2015. Removal of hexavalent chromium from aqueous solutions using micro zero-valent iron supported by bentonite layer. *Water science and technology : a journal of the International Association on Water Pollution Research* 71:667-74
110. Yasthopi A. 2015. Photoelectrospitting water for hydrogen production using illumination of indoor lights. *Journal of Chemical and Pharmaceutical Research* 7:246-56
111. Zainul R. 2015. Disain dan Modifikasi Kolektor dan Reflektor Cahaya pada Panel Sel Surya Al/Cu2O-Gel Na2SO4.
112. Mawardi Anwar E, Kosela S, Wibowo W, Zainul R. 2015. Study of Pb (II) biosorption from aqueous solution using immobilized Spirogyra subsalsa biomass. *Journal of Chemical and Pharmaceutical Research* 7:715-22
113. Desy Kurniawati I, Harmiwati SS, Chaidir Z, Munaf E, Rahmiana Zein, Hermansyah Aziz, Rahadian Zainul. 2015. Biosorption of Pb (II) from Aqueous Solutions Using Column Method by Lengkeng (Euphoria logan lour) Seed and Shell. *Journal of Chemical and Pharmaceutical Research* 7:872-7
114. Zainul R, Nurakhbari D, Salim M. Optimization of Spirulina Platensis Culture for Antioxidant Production.
115. Zhai W, Wang Y, Deng Y, Gao H, Lin Z, Li M. 2014. Recycling of asbestos tailings used as reinforcing fillers in polypropylene based composites. *Journal of hazardous materials* 270:137-43
116. Wu J, An G, Lin S, Xie J, Zhou W, et al. 2014. Solution-phase-peptide synthesis via the group-assisted purification (GAP) chemistry without using chromatography and recrystallization. *Chemical communications* 50:1259-61

117. Lari E, Wiseman S, Mohaddes E, Morandi G, Alharbi H, Pyle GG. 2016. Determining the effect of oil sands process-affected water on grazing behaviour of *Daphnia magna*, long-term consequences, and mechanism. *Chemosphere* 146:362-70
118. Tonelli M, Martini F, Calucci L, Fratini E, Geppi M, et al. 2016. Structural characterization of magnesium silicate hydrate: towards the design of eco-sustainable cements. *Dalton transactions* 45:3294-304
119. Zheng A, Cao L, Liu Y, Wu J, Zeng D, et al. 2018. Biocompatible silk/calcium silicate/sodium alginate composite scaffolds for bone tissue engineering. *Carbohydrate polymers* 199:244-55
120. Vere KA, Richens JL, Lane JS, Harris HJ, Duggan J, O'Shea P. 2013. Evidence for sodium metasilicate receptors on the human osteoblast cell surface; spatial localization and binding properties. *Molecular membrane biology* 30:386-93
121. Ryu SM, Kim SY, Song IH, Ahn MW, Lee CH, et al. 2018. Effect of water glass coating of tricalcium phosphate on in vitro cellular proliferation and osteogenic differentiation. *Journal of biomaterials applications* 33:196-204
122. Bayat M, Javanbakht V, Esmaili J. 2018. Synthesis of zeolite/nickel ferrite/sodium alginate bionanocomposite via a co-precipitation technique for efficient removal of water-soluble methylene blue dye. *International journal of biological macromolecules* 116:607-19
123. Zahedi Y, Fathi-Achachlouei B, Yousefi AR. 2018. Physical and mechanical properties of hybrid montmorillonite/zinc oxide reinforced carboxymethyl cellulose nanocomposites. *International journal of biological macromolecules* 108:863-73
124. Kim DS, Yang ES, Yong CS, Youn YS, Oh KT, et al. 2017. Effect of inorganic mesoporous carriers on 1-palmitoyl-2-linoleoyl-3-acetyl-rac-glycerol-loaded solid self-emulsifying drug delivery system: Physicochemical characterization and bioavailability in rats. *Colloids and surfaces. B, Biointerfaces* 160:331-6
125. Wang Y, Cui W, Chou J, Wen S, Sun Y, Zhang H. 2018. Electrospun nanosilicates-based organic/inorganic nanofibers for potential bone tissue engineering. *Colloids and surfaces. B, Biointerfaces* 172:90-7
126. Kloprogge JT, Wood BJ. 2015. Chemical bonding and electronic structures of microcline, orthoclase and the plagioclase series by X-ray photoelectron spectroscopy. *Spectrochimica acta. Part A, Molecular and biomolecular spectroscopy* 137:711-6
127. Adamczyk Z, Zembala M, Warszynski P, Jachimska B. 2004. Characterization of polyelectrolyte multilayers by the streaming potential method. *Langmuir : the ACS journal of surfaces and colloids* 20:10517-25
128. Zhang Y, Li T, Hou D, Zhang J, Jiang J. 2018. Insights on magnesium and sulfate ions' adsorption on the surface of sodium alumino-silicate hydrate (NASH) gel: a molecular dynamics study. *Physical chemistry chemical physics : PCCP* 20:18297-310
129. Villafane-Barajas SA, Bau JPT, Colin-Garcia M, Negron-Mendoza A, Heredia-Barbero A, et al. 2018. Salinity Effects on the Adsorption of Nucleic Acid Compounds on Na-Montmorillonite: a Prebiotic Chemistry Experiment. *Origins of life and evolution of the biosphere : the journal of the International Society for the Study of the Origin of Life* 48:181-200
130. Valdes L, Perez I, de Menorval LC, Altshuler E, Fossum JO, Rivera A. 2017. A simple way for targeted delivery of an antibiotic: In vitro evaluation of a nanoclay-based composite. *PloS one* 12:e0187879
131. Sabu S, Singh ISB, Joseph V. 2017. Optimisation of critical medium components and culture conditions for enhanced biomass and lipid production in the oleaginous diatom *Navicula phyllepta*: a statistical approach. *Environmental science and pollution research international* 24:26763-77
132. Ou L, Gannon TW, Polizzotto ML. 2017. Impact of soil organic carbon on monosodium methyl arsenate (MSMA) sorption and species transformation. *Chemosphere* 186:243-50
133. Molnar G, Ganster P, Tanguy A. 2017. Effect of composition and pressure on the shear strength of sodium silicate glasses: An atomic scale simulation study. *Physical review. E* 95:043001

134. Hou D, Hu C, Li Z. 2017. Molecular Simulation of the Ions Ultraconfined in the Nanometer-Channel of Calcium Silicate Hydrate: Hydration Mechanism, Dynamic Properties, and Influence on the Cohesive Strength. *Inorganic chemistry* 56:1881-96
135. Ulcinas A, Valdre G, Snitka V, Miles MJ, Claesson PM, Antognozzi M. 2011. Shear response of nanoconfined water on muscovite mica: role of cations. *Langmuir : the ACS journal of surfaces and colloids* 27:10351-5
136. Andruski B, McCafferty DM, Ignacy T, Millen B, McDougall JJ. 2008. Leukocyte trafficking and pain behavioral responses to a hydrogen sulfide donor in acute monoarthritis. *American journal of physiology. Regulatory, integrative and comparative physiology* 295:R814-20
137. Governa M, Amati M, Valentino M, Visona I, Fubini B, et al. 2000. In vitro cleavage by asbestos fibers of the fifth component of human complement through free-radical generation and kallikrein activation. *Journal of toxicology and environmental health. Part A* 59:539-52
138. Zhao W, Guo L, Ding M, Huang Y, Yang HY. 2018. Ultrahigh Desalination Capacity Dual-ion Electrochemical Deionization Device Based on Na₃V₂(PO₄)₃@C-AgCl Electrodes. *ACS applied materials & interfaces*
139. Li P, Zhang Y, Liang C, Xing G, Liu X, et al. 2018. Phase Pure 2D Perovskite for High-Performance 2D-3D Heterostructured Perovskite Solar Cells. *Advanced materials*:e1805323
140. Harrison JA, Kelso C, Pukala TL, Beck JL. 2018. Conditions for Analysis of Native Protein Structures Using Uniform Field Drift Tube Ion Mobility Mass Spectrometry and Characterization of Stable Calibrants for TWIM-MS. *Journal of the American Society for Mass Spectrometry*
141. Hajilar S, Shafei B. 2018. Structure, orientation, and dynamics of water-soluble ions adsorbed to basal surfaces of calcium monosulfoaluminate hydrates. *Physical chemistry chemical physics : PCCP* 20:24681-94
142. Hagemann LT, McCartney MM, Fung AG, Peirano DJ, Davis CE, Mizaikoff B. 2018. Portable combination of Fourier transform infrared spectroscopy and differential mobility spectrometry for advanced vapor phase analysis. *The Analyst*
143. Vural D, Smith JC, Petridis L. 2018. Dynamics of the lignin glass transition. *Physical chemistry chemical physics : PCCP* 20:20504-12
144. Yoo S, Ahlgren EH, Seo J, Kim W, Chiang S, Kim JS. 2018. Growth kinetics of Kr nano structures encapsulated by graphene. *Nanotechnology* 29:385601
145. Koker IH, Senturk H. 2018. Pancreas cyst fluid viscosity assesment in the diagnosis of mucinous cyts. *Gastrointestinal endoscopy* 87:1597-8
146. Pandita D, Kumari N, Lather V. 2017. A Self-nanoemulsifying Drug Delivery System for Poorly Water Soluble Tolbutamide: Development, Optimization and Pharmacodynamic Studies. *Pharmaceutical nanotechnology* 5:285-300
147. Mohan S, Gupta P, Sahai K, Sachan SK. 2014. Phacoemulsification in a Rare Case of Alport's Syndrome. *Seminars in ophthalmology* 29:196-8
148. Beg S, Swain S, Singh HP, Patra Ch N, Rao ME. 2012. Development, optimization, and characterization of solid self-nanoemulsifying drug delivery systems of valsartan using porous carriers. *AAPS PharmSciTech* 13:1416-27
149. Lightowler HJ, Henry CJ. 2009. Glycemic response of mashed potato containing high-viscosity hydroxypropylmethylcellulose. *Nutrition research* 29:551-7
150. Sivam AS, Sun-Waterhouse D, Waterhouse GI, Quek S, Perera CO. 2011. Physicochemical properties of bread dough and finished bread with added pectin fiber and phenolic antioxidants. *Journal of food science* 76:H97-H107
151. Ghahari S, Ghahari S, Nematzadeh GA. 2018. Magnetic nano fluids for isolation of genomic DNA and total RNA from various prokaryote and eukaryote cells. *Journal of chromatography. B, Analytical technologies in the biomedical and life sciences* 1102-1103:125-34
152. Schmitz M, Schubert DW, Kaschta J, Daenicke J, Walter BL, Horch RE. 2018. Is short term intraoperative application of disinfectants harmful to breast implants in breast reconstruction? An experimental study and literature survey. *Journal of the mechanical behavior of biomedical materials* 90:264-8

153. Gao G, Wang Z, Xu D, Wang L, Xu T, et al. 2018. Snap-Buckling Motivated Controllable Jumping of Thermo-Responsive Hydrogel Bilayers. *ACS applied materials & interfaces*
154. Ganesan K, Budtova T, Ratke L, Gurikov P, Baudron V, et al. 2018. Review on the Production of Polysaccharide Aerogel Particles. *Materials* 11
155. Davila JL, d'Avila MA. 2017. Laponite as a rheology modifier of alginate solutions: Physical gelation and aging evolution. *Carbohydrate polymers* 157:1-8
156. Pasquino R, Di Domenico M, Izzo F, Gaudino D, Vanzanella V, et al. 2016. Rheology-sensitive response of zeolite-supported anti-inflammatory drug systems. *Colloids and surfaces. B, Biointerfaces* 146:938-44
157. Das RK, Das M. 2015. Catalytic activity of acid and base with different concentration on sol-gel kinetics of silica by ultrasonic method. *Ultrasonics sonochemistry* 26:210-7
158. Park K, Kim D. 2016. Analysis of Homogel Uniaxial Compression Strength on Bio Grouting Material. *Materials* 9
159. Joshi N, Rawat K, Bohidar HB. 2016. Characterization of microstructure, viscoelasticity, heterogeneity and ergodicity in pectin-laponite-CTAB-calcium nanocomposite hydrogels. *Carbohydrate polymers* 136:242-9
160. Dickey B, Price R, Boyd D. 2016. Evidence of a complex species controlling the setting reaction of glass ionomer cements. *Dental materials : official publication of the Academy of Dental Materials* 32:596-605
161. Zainul R. 2016. Design and Modification of Copper Oxide Electrodes for Improving Conversion Coefficient Indoors Lights (PV-Cell) Photocells.
162. Allers M, Timoumi L, Kirk AT, Schlottmann F, Zimmermann S. 2018. Coupling of a High-Resolution Ambient Pressure Drift Tube Ion Mobility Spectrometer to a Commercial Time-of-flight Mass Spectrometer. *Journal of the American Society for Mass Spectrometry* 29:2208-17
163. Gabelica V, Livet S, Rosu F. 2018. Optimizing Native Ion Mobility Q-TOF in Helium and Nitrogen for Very Fragile Noncovalent Structures. *Journal of the American Society for Mass Spectrometry* 29:2189-98
164. Shizgal BD. 2018. Kappa and other nonequilibrium distributions from the Fokker-Planck equation and the relationship to Tsallis entropy. *Physical review. E* 97:052144
165. Huang H, Huang J, Liu H, Li J, Lin Z, et al. 2018. Manipulating the wavelength-drift of a Tm laser for resonance enhancement in an intra-cavity pumped Ho laser. *Optics express* 26:5758-68
166. Oi N, Inaba M, Okubo S, Tsuyuzaki I, Kageura T, et al. 2018. Vertical-type two-dimensional hole gas diamond metal oxide semiconductor field-effect transistors. *Scientific reports* 8:10660
167. Zeng Y, Tang F, Zhai Y, Wang X. 2017. Performance enhancement of high-field asymmetric waveform ion mobility spectrometry by applying differential-RF-driven operation mode. *The Review of scientific instruments* 88:095113
168. Li C, Guerrero A, Zhong Y, Graser A, Luna CAM, et al. 2017. Real-Time Observation of Iodide Ion Migration in Methylammonium Lead Halide Perovskites. *Small* 13
169. Horiza, H., Azhar, M. and Efendi, J. (2017) "EKSTRAKSI DAN KARAKTERISASI INULIN DARI UMBI DAHLIA (*Dahlia sp.L*) SEGAR DAN DISIMPAN", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 18(01), pp. 31-39. doi: <https://doi.org/10.24036/eksakta/vol18-iss01/14>.
170. Iryani, I., Iswendi, I. and Katrina, I. T. (2017) "UJI AKTIVITAS ANTI DIABETES MELLITUS SENYAWA METABOLIT SEKUNDER FRAKSI AIR DARI BERAS KETAN HITAM (*Oryza satival. Var glutinosa*) PADA MENCIT PUTIH", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 18(01), pp. 54-60. doi: <https://doi.org/10.24036/eksakta/vol18-iss01/17>.
171. Suryelita, S., Etika, S. B. and Kurnia, N. S. (2017) "ISOLASI DAN KARAKTERISASI SENYAWA STEROID DARI DAUN CEMARA NATAL (*Cupressus funebris* Endl.)", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 18(01), pp. 86-94. doi: <https://doi.org/10.24036/eksakta/vol18-iss01/23>.

172. Iskandar, I., Horiza, H. and Fauzi, N. (2017) "EFEKTIVITAS BUBUK BIJI PEPAYA (Carica Papaya Linnaeus) SEBAGAI LARVASIDA ALAMI TERHADAP KEMATIAN LARVA AEDES AEGYPTI TAHUN 2015", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 18(01), pp. 12-18. doi: <https://doi.org/10.24036/eksakta/vol18-iss01/12>.
173. Ramli, R., Jonuarti, R. and Hartono, A. (2017) "ANALISIS STRUKTUR NANO DARI LAPISAN TIPIS COBALT FERRITE YANG DIPREPARASI DENGAN METODE SPUTTERING", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 18(01), pp. 46-53. doi: <https://doi.org/10.24036/eksakta/vol18-iss01/16>.
174. Sanjaya, H. (2017) "DEGRADASI METHYLENE BLUE MENGGUNAKAN KATALIS ZnO-PEG DENGAN METODE FOTOSONOLISIS", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 18(02), pp. 21-29. doi: <https://doi.org/10.24036/eksakta/vol18-iss02/45>.
175. Ningsih, S. K. (2017) "SINTESIS DAN KARAKTERISASI NANOPARTIKEL ZnO DOPED Cu²⁺ MELALUI METODA SOL-GEL", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 18(02), pp. 39-51. doi: <https://doi.org/10.24036/eksakta/vol18-iss02/51>.
176. Saiya, A. (2017) "ANALISIS RESIDU KLOPIRIFOS DALAM SAYURAN KUBIS DENGAN METODE HPLC DI BEBERAPA PASAR TRADISIONAL DI SULAWESI UTARA", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 18(02), pp. 77-85. doi: <https://doi.org/10.24036/eksakta/vol18-iss02/57>.
177. Nahin M, Oberreit D, Fukushima N, Larriba-Andaluz C. 2017. Modeling of an Inverted Drift Tube for Improved Mobility Analysis of Aerosol Particles. *Scientific reports* 7:6456
178. Wang Z, Ivory C, Minerick AR. 2017. Surface isoelectric focusing (sIEF) with carrier ampholyte pH gradient. *Electrophoresis* 38:2565-75
179. Chen C, Chen H, Li H. 2017. Pushing the Resolving Power of Tyndall-Powell Gate Ion Mobility Spectrometry over 100 with No Sensitivity Loss for Multiple Ion Species. *Analytical chemistry* 89:13398-404
180. Bohnhorst A, Kirk AT, Berger M, Zimmermann S. 2018. Fast Orthogonal Separation by Superposition of Time of Flight and Field Asymmetric Ion Mobility Spectrometry. *Analytical chemistry* 90:1114-21
181. Habchi B, Alves S, Jouan-Rimbaud Bouveresse D, Appenzeller B, Paris A, et al. 2018. Potential of dynamically harmonized Fourier transform ion cyclotron resonance cell for high-throughput metabolomics fingerprinting: control of data quality. *Analytical and bioanalytical chemistry* 410:483-90
182. Jaervinen AE, Allen SL, Eldon D, Fenstermacher ME, Groth M, et al. 2018. ExB Flux Driven Detachment Bifurcation in the DIII-D Tokamak. *Physical review letters* 121:075001
183. Heorton H, Feltham DL, Tsamados M. 2018. Stress and deformation characteristics of sea ice in a high-resolution, anisotropic sea ice model. *Philosophical transactions. Series A, Mathematical, physical, and engineering sciences* 376
184. Zhao Y, Cai C, Zhang J, Cao X, Wang L, et al. 2018. Feedback-enabled adaptive underwater twisted light transmission link utilizing the reflection at the air-water interface. *Optics express* 26:16102-12
185. Strate A, Neumann J, Overbeck V, Bonsa AM, Michalik D, et al. 2018. Rotational and translational dynamics and their relation to hydrogen bond lifetimes in an ionic liquid by means of NMR relaxation time experiments and molecular dynamics simulation. *The Journal of chemical physics* 148:193843
186. Syafei, N. (2017) "ANALISA FENOMENA KOROSI PELAT PIPA BAJA KARBON API 5L-X65 DALAM LARUTAN 250 ML ASAM ASETAT DAN 4750 ML AQUADES PADA KONDISI GAS CO₂ DAN H₂S JENUH PADA SUHU RUANG", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 18(02), pp. 113-120. doi: <https://doi.org/10.24036/eksakta/vol18-iss02/63>.
187. Tutuarima, T. (2017) "SIFAT FISIKA DAN KIMIA MARMALADE JERUK KALAMANSI (Citrus microcarpa) : KAJIAN KONSENTRASI PEKTIN DAN SUKROSA Physical and Chemical Properties of Marmalade Citrus of Calamondin (Citrus microcarpa) : Study of Pectin and Sucrose Concentrations", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 18(02), pp. 164-172. doi: <https://doi.org/10.24036/eksakta/vol18-iss02/73>.

188. Ruswandi, R. (2018) "Determination of Fructose Content resulted by Inulin Hydrolysis with DNS as Oxidizer", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 19(1), pp. 14-23. doi: <https://doi.org/10.24036/eksakta/vol19-iss1/102>.
189. Sanjaya, H. (2018) "DEGRADASI METIL VIOLET MENGGUNAKAN KATALIS ZnO-TiO₂ SECARA FOTOSONOLISIS", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 19(1), pp. 91-99. doi: <https://doi.org/10.24036/eksakta/vol19-iss1/131>.
190. Hidayani, T. (2018) "GRAFTING POLIPROPILENA DENGAN MALEAT ANHIDRIDA SEBAGAI PENGIKAT SILANG DENGAN INISIATOR BENZOIL PEROKSIDA", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 19(1), pp. 56-62. doi: <https://doi.org/10.24036/eksakta/vol19-iss1/127>.
191. Prabowo, H. (2018) "PENYELIDIKAN KELAYAKAN KIMIA DAN PENYEBARAN CADANGAN PASIR BESI DAERAH TIKU KABUPATEN AGAM UNTUK BAHAN BAKU SEMEN PADA PT. SEMEN PADANG", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 19(1), pp. 39-42. doi: <https://doi.org/10.24036/eksakta/vol19-iss1/121>.
192. Syafei, N. (2018) "Riset Material ANALISA FENOMENA KOROSI PELAT PIPA BAJA KARBON API 5L-X65 DALAM LARUTAN 7900 ML AIR LAUT DAN 100 ML AMONIAK PADA KONDISI GAS CO₂ DAN H₂S JENUH PADA SUHU RUANG.", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 19(1), pp. 7-13. doi: <https://doi.org/10.24036/eksakta/vol19-iss1/83>.
193. Parbuntari, H., Prestica, Y., Gunawan, R., Nurman, M. and Adella, F. (2018) "Preliminary Phytochemical Screening (Qualitative Analysis) of Cacao Leaves (*Theobroma cacao* L.)", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 19(2), pp. 40-45. doi: <https://doi.org/10.24036/eksakta/vol19-iss2/142>.
194. Dinata, M. and Soehardi, F. (2018) "Factor Analysis of Physics Chemistry Waters that Affects Damage Safety Cliff on the Outskirts of River Siak", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 19(2), pp. 46-49. doi: <https://doi.org/10.24036/eksakta/vol19-iss2/143>.
195. Hong SB, Jeong JM, Kang HG, Seo D, Cha Y, et al. 2018. Fast and Scalable Hydrodynamic Synthesis of MnO₂/Defect-Free Graphene Nanocomposites with High Rate Capability and Long Cycle Life. *ACS applied materials & interfaces*
196. Roman J, Francois O, Jarroux N, Patriarche G, Pelta J, et al. 2018. Solid-State Nanopore Easy Chip Integration in a Cheap and Reusable Microfluidic Device for Ion Transport and Polymer Conformation Sensing. *ACS sensors* 3:2129-37
197. Siddiqi KS, Rashid M, Rahman A, Tajuddin, Husen A, Rehman S. 2018. Biogenic fabrication and characterization of silver nanoparticles using aqueous-ethanolic extract of lichen (*Usnea longissima*) and their antimicrobial activity. *Biomaterials research* 22:23
198. Kim TH, Yang CS, Oh JH, Ouchi K. 2014. Analysis of the contribution of wind drift factor to oil slick movement under strong tidal condition: Hebei Spirit oil spill case. *PloS one* 9:e87393
199. Vladimirov AG, Pimenov A, Gurevich SV, Panajotov K, Averlant E, Tlidi M. 2014. Cavity solitons in vertical-cavity surface-emitting lasers. *Philosophical transactions. Series A, Mathematical, physical, and engineering sciences* 372
200. Karalunas SL, Huang-Pollock CL. 2013. Integrating impairments in reaction time and executive function using a diffusion model framework. *Journal of abnormal child psychology* 41:837-50
201. Wang Q, Yue Y, Anderson J. 2018. Detection and compensation of power imbalance, modulation strength, and bias drift in coherent IQ transmitter through digital filter. *Optics express* 26:23069-83
202. Mukherjee C, Beall CJ, Griffen AL, Leys EJ. 2018. High-resolution ISR amplicon sequencing reveals personalized oral microbiome. *Microbiome* 6:153
203. Fu Y, Chen Z, Sun J. 2018. Random drift particle swarm optimisation algorithm for highly flexible protein-ligand docking. *Journal of theoretical biology* 457:180-9
204. Cullis PS, Cull F, Bruce G, Johnston A, Patel H, et al. 2018. Quantification of urinary sodium concentrations in term infants. *Annals of clinical biochemistry*:4563218796592

205. Zhang B, Zhang Q, Bai Y. 2018. Antiferromagnetic monolayer MnC₂ with density functional theory prediction. *Journal of physics. Condensed matter : an Institute of Physics journal* 30:175301
206. Gyergyek T, Kovacic J. 2017. Numerical analysis of ion temperature effects to the plasma wall transition using a one-dimensional two-fluid model. I. Finite Debye to ionization length ratio. *Physics of plasmas* 24:063505
207. Le Deunff E, Tournier PH, Malagoli P. 2016. The Thermodynamic Flow-Force Interpretation of Root Nutrient Uptake Kinetics: A Powerful Formalism for Agronomic and Phytoplanktonic Models. *Frontiers in physiology* 7:243
208. Lazkoz R, Leanizbarrutia I, Salzano V. 2018. Forecast and analysis of the cosmological redshift drift. *The European physical journal. C, Particles and fields* 78:11
209. Vukelic A, Cohen JA, Sullivan AP, Perry GH. 2017. Extending Genome-Wide Association Study Results to Test Classic Anthropological Hypotheses: Human Third Molar Agenesis and the "Probable Mutation Effect". *Human biology* 89:157-69
210. Parastar F, Hejazi SM, Sheikhzadeh M, Alirezazadeh A. 2017. A parametric study on hydraulic conductivity and self-healing properties of geotextile clay liners used in landfills. *Journal of environmental management* 202:29-37
211. Zhu J, Tang C, Zhuang Z, Shi C, Li N, et al. 2017. Porous and Low-Crystalline Manganese Silicate Hollow Spheres Wired by Graphene Oxide for High-Performance Lithium and Sodium Storage. *ACS applied materials & interfaces* 9:24584-90
212. Cizman A, Rysiakiewicz-Pasek E, Krupinski M, Konon M, Antropova T, Marszalek M. 2017. The effect of Fe on the structure and electrical conductivity of sodium borosilicate glasses. *Physical chemistry chemical physics : PCCP* 19:23318-24
213. Chen L, Wang Z, Wang Y, Feng J. 2016. Preparation and Properties of Alkali Activated Metakaolin-Based Geopolymer. *Materials* 9
214. Toh GM, Corcoran RC, Dutta D. 2010. Sodium silicate based sol-gel structures for generating pressure-driven flow in microfluidic channels. *Journal of chromatography. A* 1217:5004-11
215. Matsumoto M, Koibuchi S, Hayashi N. 2007. Electric birefringence and streaming-electric birefringence of synthesized imogolite: the anisotropy of electric polarizability. *Colloids and surfaces. B, Biointerfaces* 56:107-13
216. Bauder TA, Barbarick KA, Ippolito JA, Shanahan JF, Ayers PD. 2005. Soil properties affecting wheat yields following drilling-fluid application. *Journal of environmental quality* 34:1687-96
217. Feuerstein M, Hunger M, Engelhardt G, Amoureux JP. 1996. Characterisation of sodium cations in dehydrated zeolite NaX by ²³Na NMR spectroscopy. *Solid state nuclear magnetic resonance* 7:95-103
218. Hunger M, Engelhardt G, Koller H, Weitkamp J. 1993. Characterization of sodium cations in dehydrated faujasites and zeolite EMT by ²³Na DOR, 2D nutation, and MAS NMR. *Solid state nuclear magnetic resonance* 2:111-20
219. Kumar Awasthi M, Wang M, Pandey A, Chen H, Kumar Awasthi S, et al. 2017. Heterogeneity of zeolite combined with biochar properties as a function of sewage sludge composting and production of nutrient-rich compost. *Waste management* 68:760-73
220. Zheng J, Teng G, Yang J, Xu M, Yao Q, et al. 2018. Mechanism of Exact Transition between Cationic and Anionic Redox Activities in Cathode Material Li₂FeSiO₄. *The journal of physical chemistry letters*:6262-8
221. Mansouri-Torshizi H, Zareian-Jahromi S, Abdi K, Saeidifar M. 2018. Nonionic but water soluble, [Glycine-Pd-Alanine] and [Glycine-Pd-Valine] complexes. Their synthesis, characterization, antitumor activities and rich DNA/HSA interaction studies. *Journal of biomolecular structure & dynamics*:1-46
222. Starzonek S, Kedzierska-Sar A, Drozd-Rzoska A, Szafran M, Rzoska SJ. 2018. Unique dynamic crossover in supercooled x,3-dihydroxypropyl acrylate (x = 1, 2) isomers mixture. *The European physical journal. E, Soft matter* 41:108

223. Yu AS, Yue Z, Feng J, Yue L. 2018. Regulation of Orai/STIM Channels by pH. In *Calcium Entry Channels in Non-Excitable Cells*, ed. JA Kozak, JW Putney, Jr.:161-76. Boca Raton (FL). Number of 161-76 pp.
224. Dong D, Bedrov D. 2018. Charge Transport in [Li(tetraglyme)][bis(trifluoromethane)sulfonimide] Solvate Ionic Liquids: Insight from Molecular Dynamics Simulations. *The journal of physical chemistry. B* 122:9994-10004
225. Wang X, Tian J, Cheng X, Na R, Wang D, Shan Z. 2018. Chitosan-Induced Synthesis of Hierarchical Flower Ridge-like MoS₂/N-Doped Carbon Composites with Enhanced Lithium Storage. *ACS applied materials & interfaces* 10:35953-62
226. Guberovic I, Marjanovic M, Mioc M, Ester K, Martin-Kleiner I, et al. 2018. Crown ethers reverse P-glycoprotein-mediated multidrug resistance in cancer cells. *Scientific reports* 8:14467
227. Anwar T, Samudrala G. 2018. Bioinformatics Analysis and Functional Prediction of Transmembrane Proteins in *Entamoeba histolytica*. *Genes* 9
228. Xu D, Jin J, Chen C, Wen Z. 2018. From Nature to Energy Storage: A Novel Sustainable 3D Cross-Linked Chitosan-PEGGE Based Gel Polymer Electrolyte with Excellent Lithium Ion Transport Properties for Lithium Batteries. *ACS applied materials & interfaces*
229. Manghi M, Palmeri J, Yazda K, Henn F, Jourdain V. 2018. Role of charge regulation and flow slip in the ionic conductance of nanopores: An analytical approach. *Physical review. E* 98:012605
230. Clark N, Nguyen L, Hamer MJ, Schedin F, Lewis EA, et al. 2018. Scalable Patterning of Encapsulated Black Phosphorus. *Nano letters*
231. Jayaraman K, Morley AN, Szollosi D, Wassenaar TA, Sitte HH, Stockner T. 2018. Dopamine transporter oligomerization involves the scaffold domain, but spares the bundle domain. *PLoS computational biology* 14:e1006229
232. Ma L, Liu M, Yan Y, Qing C, Zhang X, et al. 2018. Genetic Dissection of Maize Embryonic Callus Regenerative Capacity Using Multi-Locus Genome-Wide Association Studies. *Frontiers in plant science* 9:561
233. Mushtaq A, Mustafa M, Hayat T, Alsaedi A. 2018. Buoyancy effects in stagnation-point flow of Maxwell fluid utilizing non-Fourier heat flux approach. *PloS one* 13:e0192685
234. Sowa JK, Mol JA, Briggs GAD, Gauger EM. 2018. Beyond Marcus theory and the Landauer-Buttiker approach in molecular junctions: A unified framework. *The Journal of chemical physics* 149:154112
235. Cyr DG, Dufresne J, Gregory M. 2018. Cellular junctions in the epididymis, a critical parameter for understanding male reproductive toxicology. *Reproductive toxicology* 81:207-19
236. Karmann J, Muller B, Hammes UZ. 2018. The long and winding road: transport pathways for amino acids in Arabidopsis seeds. *Plant reproduction* 31:253-61
237. Choi S, Hu YM, Corkins ME, Palmer AE, Bird AJ. 2018. Zinc transporters belonging to the Cation Diffusion Facilitator (CDF) family have complementary roles in transporting zinc out of the cytosol. *PLoS genetics* 14:e1007262
238. Rojas-Canales DM, Waibel M, Forget A, Penko D, Nitschke J, et al. 2018. Oxygen-permeable microwell device maintains islet mass and integrity during shipping. *Endocrine connections* 7:490-503
239. Geffroy G, Benyahia R, Frey S, Desquirit-Dumas V, Gueguen N, et al. 2018. The accumulation of assembly intermediates of the mitochondrial complex I matrix arm is reduced by limiting glucose uptake in a neuronal-like model of MELAS syndrome. *Biochimica et biophysica acta. Molecular basis of disease* 1864:1596-608
240. Rahmatalla S, DeShaw J, Stille J, Denning G, Jennissen C. 2018. Comparing the Efficacy of Methods for Immobilizing the Thoracic-Lumbar Spine. *Air medical journal* 37:178-85
241. Galli LM, Santana F, Apollon C, Szabo LA, Ngo K, Burrus LW. 2018. Direct visualization of the Wntless-induced redistribution of WNT1 in developing chick embryos. *Developmental biology* 439:53-64

242. Maresca JA, Miller KJ, Keffer JL, Sabanayagam CR, Campbell BJ. 2018. Distribution and Diversity of Rhodopsin-Producing Microbes in the Chesapeake Bay. *Applied and environmental microbiology* 84
243. Graham TR, Han KS, Dembowski M, Krzysko AJ, Zhang X, et al. 2018. (27)Al Pulsed Field Gradient, Diffusion-NMR Spectroscopy of Solvation Dynamics and Ion Pairing in Alkaline Aluminate Solutions. *The journal of physical chemistry. B*
244. Gise R, Truong T, Poulsen DM, Soliman Y, Parsikia A, Mbekeani JN. 2018. Pediatric traumatic brain injury and ocular injury. *Journal of AAPOS : the official publication of the American Association for Pediatric Ophthalmology and Strabismus*
245. Hu Y, Acharya S, Abidi N. 2018. Cellulose porosity improves its dissolution by facilitating solvent diffusion. *International journal of biological macromolecules*
246. Kanjanahattakij N, Rattanawong P, Krishnamoorthy P, Sirinvaravong N, Chongsathidkiet P, et al. 2018. Anaemia and mortality in patients with transcatheter aortic valve replacement: a systematic review and meta-analysis. *Acta cardiologica*:1-7
247. Pillemer S, Ayers E, Holtzer R. 2018. Gender-stratified analyses reveal longitudinal associations between social support and cognitive decline in older men. *Aging & mental health*:1-7
248. Hill NL, Mogle J. 2018. Alzheimer's disease risk factors as mediators of subjective memory impairment and objective memory decline: protocol for a construct-level replication analysis. *BMC geriatrics* 18:260
249. Porter JK, Di Tanna GL, Lipton RB, Sapra S, Villa G. 2018. Costs of Acute Headache Medication Use and Productivity Losses Among Patients with Migraine: Insights from Three Randomized Controlled Trials. *PharmacoEconomics - open*
250. Paes AT, Dias BF, Eleuterio GN, Paula VP. 2018. Profile of medical students in the first group of the Faculdade Israelita de Ciencias da Saude Albert Einstein. *Einstein* 16:eAO4228
251. Schwartz CE, Zhang J, Rapkin BD, Finkelstein JA. 2018. Reconsidering the minimally important difference: evidence of instability over time and across groups. *The spine journal : official journal of the North American Spine Society*
252. Wang T, Hosgood HD, Lan Q, Xue X. 2018. The Relationship Between Population Attributable Fraction and Heritability in Genetic Studies. *Frontiers in genetics* 9:352
253. Katz MJ, Wang C, Derby CA, Lipton RB, Zimmerman ME, et al. 2018. Subjective Cognitive Decline Prediction of Mortality: Results from the Einstein Aging Study. *Journal of Alzheimer's disease : JAD* 66:239-48
254. Gellhorn AC, Stumph JM, Zikry HE, Creelman CA, Welbel R. 2018. Ultrasound measures of muscle thickness may be superior to strength testing in adults with knee osteoarthritis: a cross-sectional study. *BMC musculoskeletal disorders* 19:350
255. Seixas AA, Vallon J, Barnes-Grant A, Butler M, Langford AT, et al. 2018. Mediating effects of body mass index, physical activity, and emotional distress on the relationship between short sleep and cardiovascular disease. *Medicine* 97:e11939
256. Ren Y, Korom M, Truong R, Chan D, Huang SH, et al. 2018. Susceptibility to Neutralization by Broadly Neutralizing Antibodies Generally Correlates with Infected Cell Binding for a Panel of Clade B HIV Reactivated from Latent Reservoirs. *Journal of virology*
257. Luque Ruiz I, Gomez-Nieto MA. 2018. Regression Modelability Index: A New Index for Prediction of the Modelability of Data Sets in the Development of QSAR Regression Models. *Journal of chemical information and modeling* 58:2069-84
258. Wassef AWA, Rodes-Cabau J, Liu Y, Webb JG, Barbanti M, et al. 2018. The Learning Curve and Annual Procedure Volume Standards for Optimum Outcomes of Transcatheter Aortic Valve Replacement: Findings From an International Registry. *JACC. Cardiovascular interventions* 11:1669-79
259. Chuang E, Gil EN, Gao Q, Kligler B, McKee MD. 2018. Relationship Between Opioid Analgesic Prescription and Unemployment in Patients Seeking Acupuncture for Chronic Pain in Urban Primary Care. *Pain medicine*
260. Kraft I, Balardin JB, Sato JR, Sommer J, Tobo P, et al. 2018. Quality of life is related to the functional connectivity of the default mode network at rest. *Brain imaging and behavior*

261. Marks E, Wang Y, Shi Y, Susa J, Jacobson M, Goldstein DY. 2018. Specific TCR gene rearrangements in mycosis fungoides: does advanced clinical stage show a preference? *Journal of clinical pathology*
262. Merhi Z. 2018. Crosstalk between advanced glycation end products and vitamin D: A compelling paradigm for the treatment of ovarian dysfunction in PCOS. *Molecular and cellular endocrinology*
263. Mo S, Zhang Q, Ren Q, Xiong J, Zhang M, et al. 2018. Leaf-like Co-ZIF-L derivatives embedded on Co₂AlO₄/Ni foam from hydrotalcites as monolithic catalysts for toluene abatement. *Journal of hazardous materials* 364:571-80
264. Sofyanita, S. and Octaria, Z. (2018) "Fenthion Compound Degradation in the Pesticide Bayleton 500 ec in Sonolysis, Ozonolysis and Sonozolysis with Addition of TiO₂-anatase", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 19(2), pp. 70-79. doi: <https://doi.org/10.24036/eksakta/vol19-iss2/153>.
265. Harahap, F. and Lubis, L. (2018) "Analysis of Heavy Metals Distribution in the River Town of Hamasaki's Rod Padangsidimpuan", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 19(2), pp. 50-56. doi: <https://doi.org/10.24036/eksakta/vol19-iss2/149>.
266. Syafei, N., Hidayat, D., Emilliano, E. and Men, L. (2018) "Analysis Cracking Corrosion on Carbon Steel Pipes API 5L-X65 In Solution 7700 ml Aquades, 250 ml Acetic Acid and 50 ml Ammonia with Gas CO₂ and H₂S in Saturation Condition", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 19(2), pp. 21-31. doi: <https://doi.org/10.24036/eksakta/vol19-iss2/138>.
267. Yang H, Zhao J, Qiu M, Sun P, Han D, et al. 2018. Hierarchical bi-continuous Pt decorated nanoporous Au-Sn alloy on carbon fiber paper for ascorbic acid, dopamine and uric acid simultaneous sensing. *Biosensors & bioelectronics* 124-125:191-8
268. Zhang Y, Wang M, Wang Y, Feng J, Zhang Y, et al. 2018. Label-free photoelectrochemical immunosensor for amyloid beta-protein detection based on SnO₂/CdCO₃/CdS synthesized by one-pot method. *Biosensors & bioelectronics* 126:23-9
269. Ponnampalam EN, Kerr MG, Butler KL, Cottrell JJ, Dunshea FR, Jacobs JL. 2018. Filling the out of season gaps for lamb and hogget production: Diet and genetic influence on carcass yield, carcass composition and retail value of meat. *Meat science* 148:156-63
270. Friedfeld MR, Stein JL, Ritchhart A, Cossairt BM. 2018. Conversion Reactions of Atomically Precise Semiconductor Clusters. *Accounts of chemical research*