



Pengaruh Metode Pelapisan dan Ketebalan Lapisan terhadap Rugi Refleksi pada Barium M-Heksaferrit/Poly(aniline, pyrrole, ethylene terephthalate) sebagai Material Penyerap Radar

Nia Sasria
2714201009

Pembimbing :
Dr. Widyastuti, S.Si, M.Si
Dr. Eng. Hosta Ardhyananta, S.T., M.Sc

**PROGRAM STUDI MAGISTER
JURUSAN TEKNIK MATERIAL DAN METALURGI FTI-ITS
SURABAYA 2016**



Pendahuluan

Latar Belakang

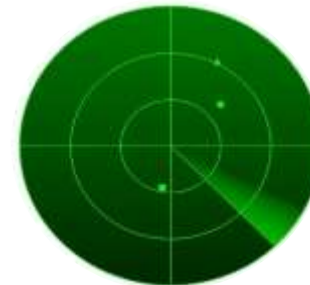
Kapal Biasa



Radar Cross Section (RCS)

Target	RCS (m ²)
Aircraft carrier	100.000
Cruiser	10,000
Large airliner or automobile	100
Medium airliner or bomber	40
Large fighter	6
Small fighter	2
Man	1
Conventional cruise missile	0.5
Large bird	0.05
Large insect	0.001
Small bird	0.00001
Small insect	0.000001

Kapal Siluman



Receiver



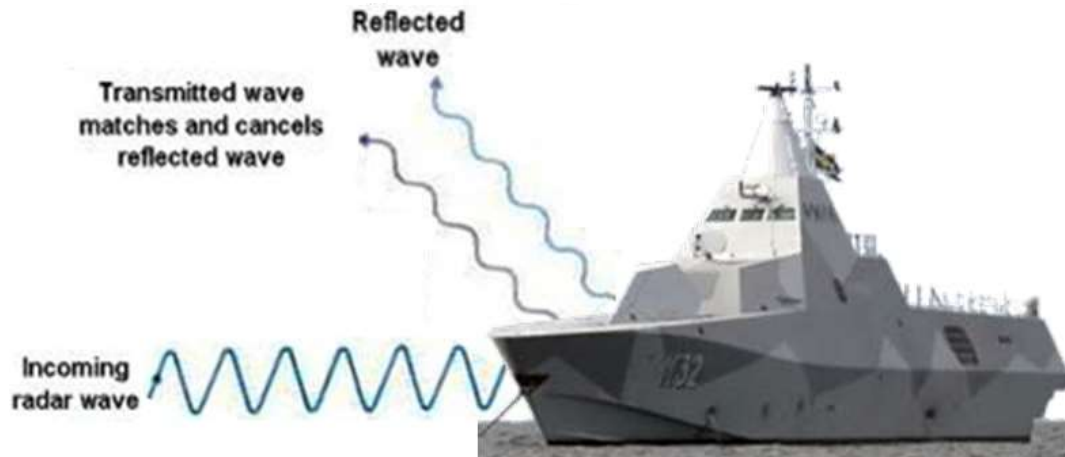
Stealth Ship Technology



Stealth Ship Technology

RAM

RAS



Desain body bersudut

Material Magnetik

Ferrimagnetik

Barium M-Heksaferrit

Metode Sol-Gel

Komposit RAM

Material Dielektrik

Polimer Konduktif

Pani, PET, PPy

Metode Polimerisasi Kimia



Variabel Penelitian



Jenis Polimer

Polianilin (PAni)
Polietilen Tereftalat (PET)
Polipirol (PPy)

Metode Pelapisan

Dallenbach Layer
Salisbury Screen
Jaumann Layer

Ketebalan Lapisan

2 mm
4 mm
6 mm

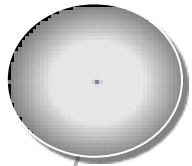


Rumusan Masalah

- 1** Bagaimana pengaruh jenis polimer terhadap sifat rugi refleksi dari komposit BaM/(Pani,PPy,PET) ?
- 2** Bagaimana pengaruh metode pelapisan komposit terhadap sifat rugi refleksi dari komposit BaM/(Pani,PPy,PET) ?
- 3** Bagaimana pengaruh ketebalan lapisan komposit terhadap sifat rugi refleksi dari komposit BaM/(Pani,PPy,PET) ?

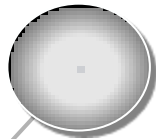


RoadMap Penelitian



Haoting, 2010

- BaM/PAni (rasio 1/2)(Sol-Gel/Polimerisasi in situ)
RL = -12 dB pada 21.5 GHz



Rinata, 2011

- BaM/PET (rasio 1/2.3)(Kopresipitasi/Polimerisasi Massa)
Dallenbach Layer, RL = -13.507 dB pada 8.5 GHz dan t = 6 mm



Wang, 2012

- BaM/PPy (rasio 1/1)(Sol-Gel/Polimerisasi in situ)
RL = -21,5 dB pada 10,7 GHz dan t= 3 mm



Amalia, 2014

- BaM/PAni (Kopresipitasi/Polimerisasi in situ)
Dallenbach Layer, RL = -36.42 dB pada 9.3 GHz dan t = 4 mm



Agustianto, 2015

- BaM/NiZn (Sol-Gel)
Ms = 72 → 95.45 emu/g, Hc = 0.67 T → 0.09 T





Kajian Pustaka Dan Dasar Teori

Radar Absorbing Material (RAM)

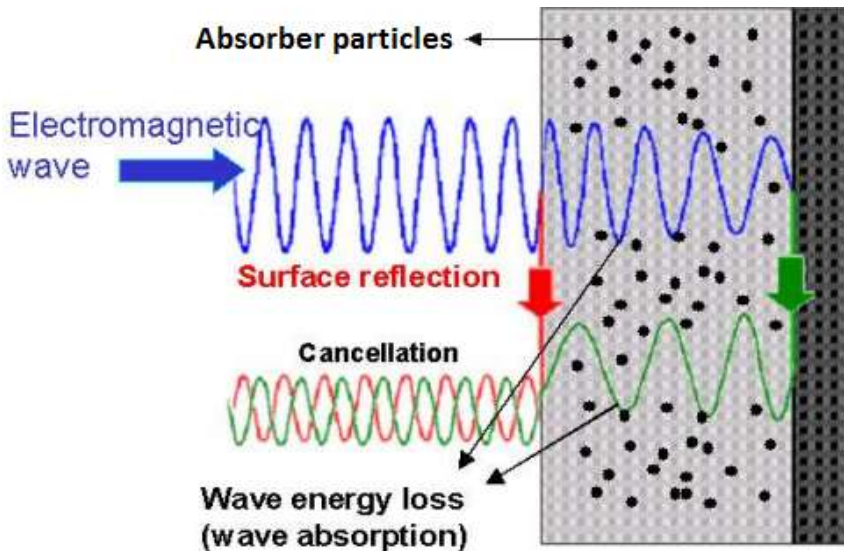
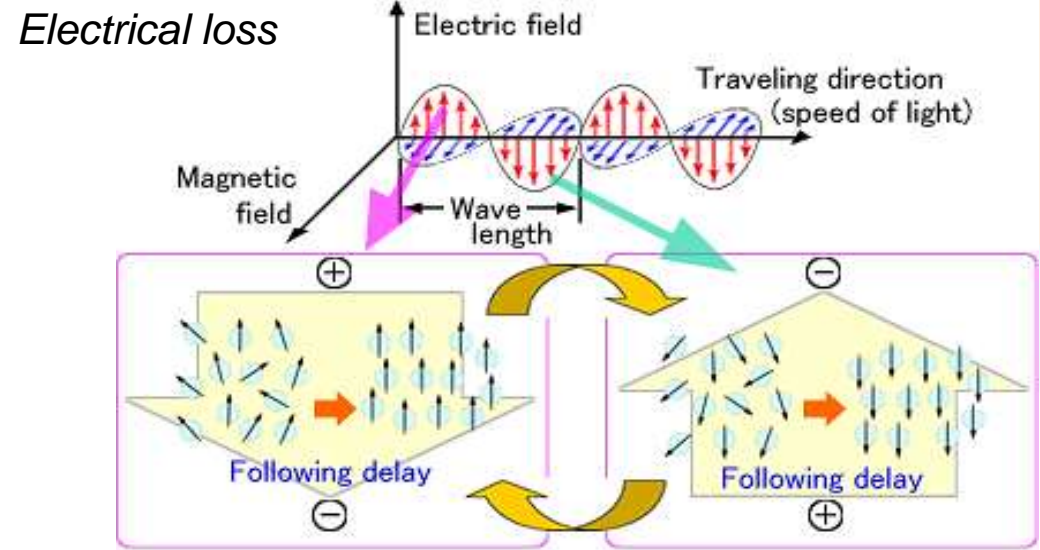
Mekanisme RAM

Electrical Loss

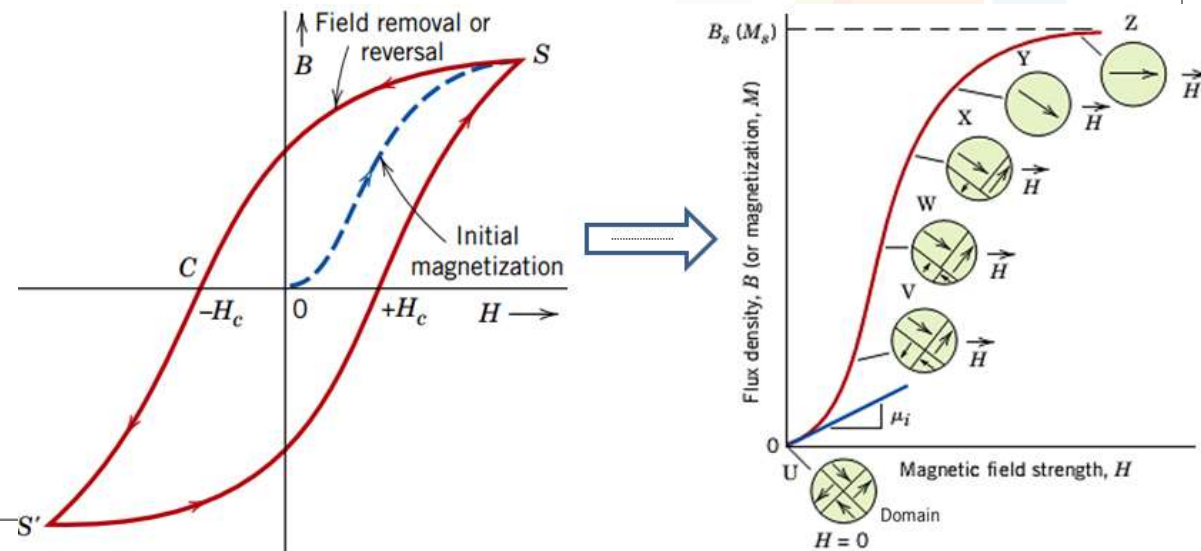
gerakan elektron bebas pada material konduktif dan pergerakan dipol-dipol listrik akibat medan listrik GEM pada material dielektrik

Magnetical Loss

rotasi dipol magnetik akibat medan magnetik GEM (H) pada material magnetik



Magnetical loss



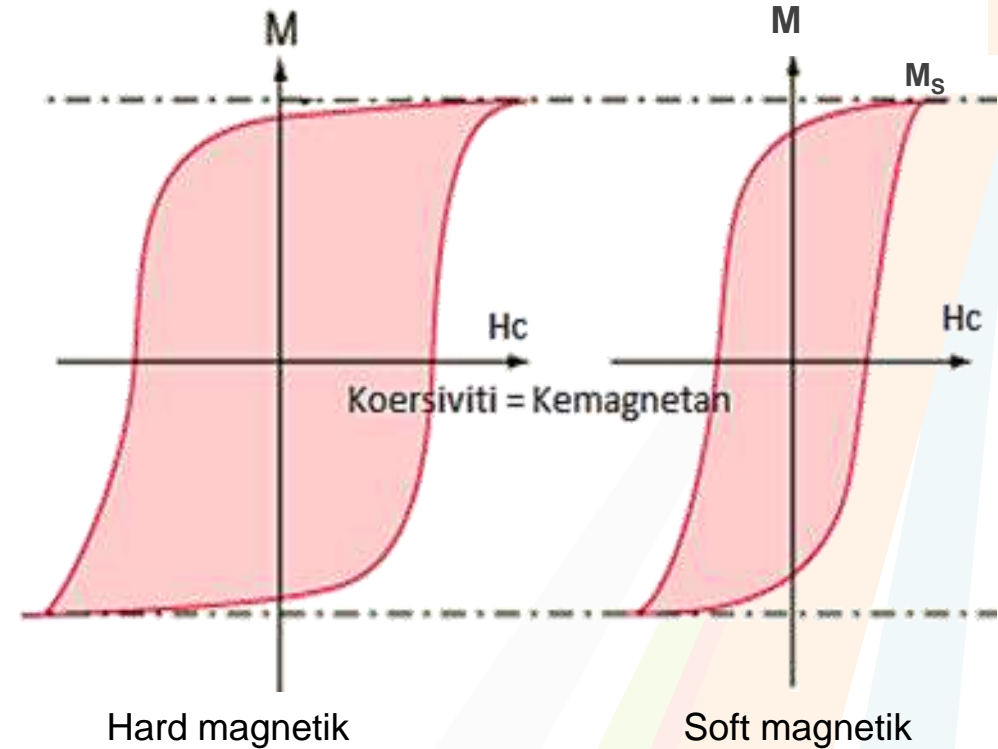


➔ Material Komposit RAM

Barium M-Heksaferit ($\text{BaFe}_{12}\text{O}_{19}$)

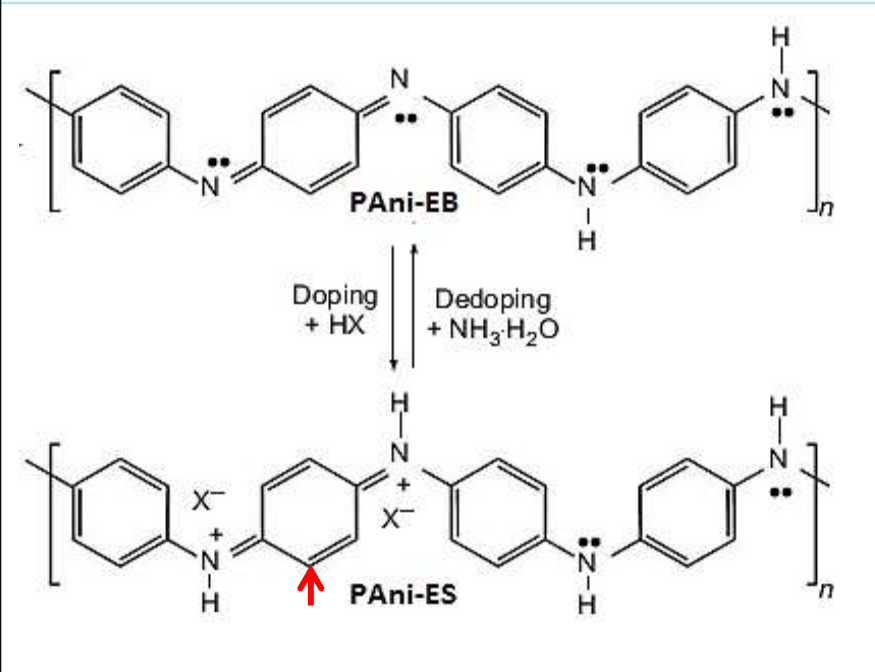
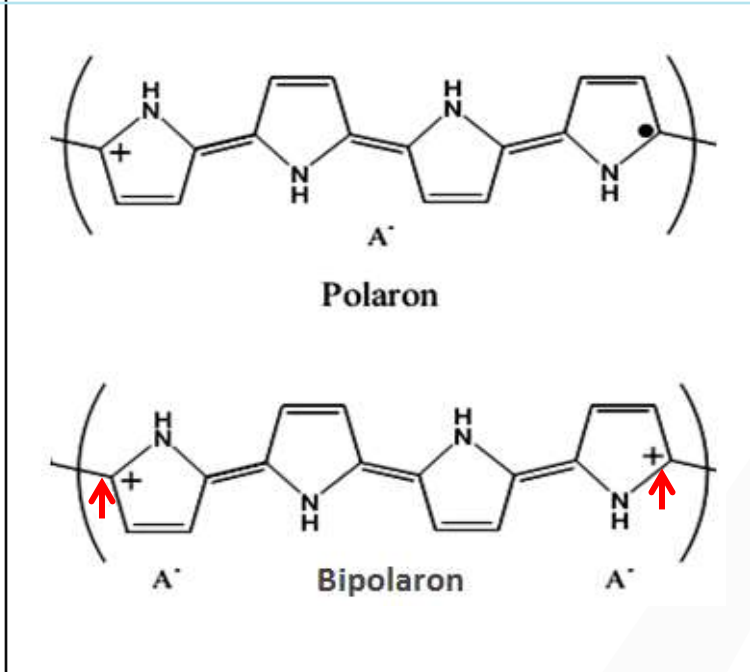
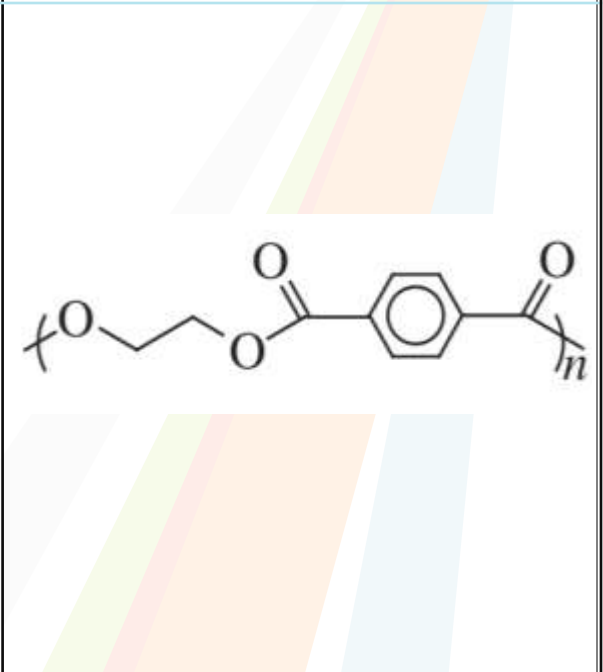
Material Properties	Barium M- Heksaferit
Melting point	1500 °C
Curie Temperatur	450 °C
Titik leleh	± 1500 °C
Koersifitas (H_c)	6700 Oe
Sifat magnetik	Hard Magnetik
Saturasi (M_s)	78 emu/g

- Uji VSM untuk menganalisis sifat magnetik, berupa magnetik saturasi dan koersivitas
- Pendopingan Ni/Zn memperkecil nilai koersivitas dari 0,23 menjadi 0,09 Tesla sehingga bersifat *softmagnetic* (Agustianto, 2015)





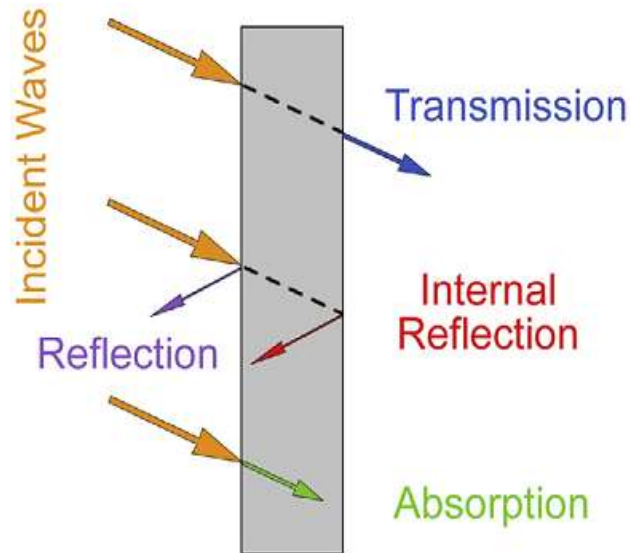
Jenis Polimer

PAni (Polianilin)	PPy (Polipirol)	PET Poly(ethylene terephthalate)
(C₆H₅NH₂)_n	(C₄H₄NH)_n	(C₁₀H₈O₄)_n
 <p>PAni-EB</p> <p>Doping + HX</p> <p>Dedoping + NH₃.H₂O</p> <p>PAni-ES</p>	 <p>A[•]</p> <p>Polaron</p> <p>A⁺</p> <p>Bipolaron</p> <p>A⁺</p>	 <p>PET</p>



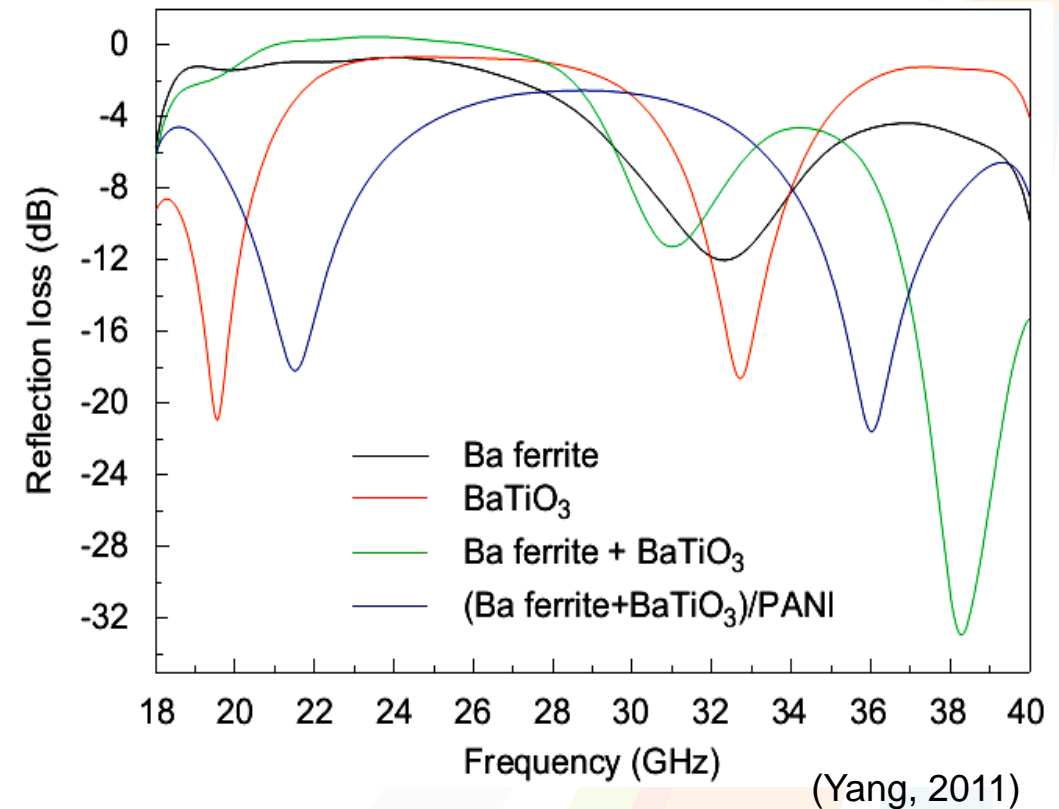
Rugi Refleksi Gelombang Mikro

Penyerapan Gelombang Mikro



Semakin besar nilai negatif rugi refleksi maka semakin besar daya serap bahan terhadap gelombang mikro

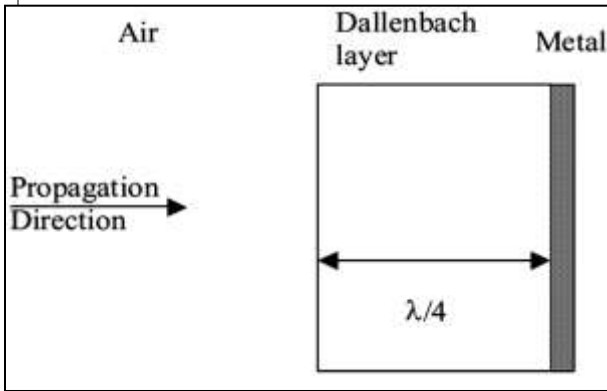
Nilai rugi refleksi melalui Uji VNA (*Vector Network Analyzer*)



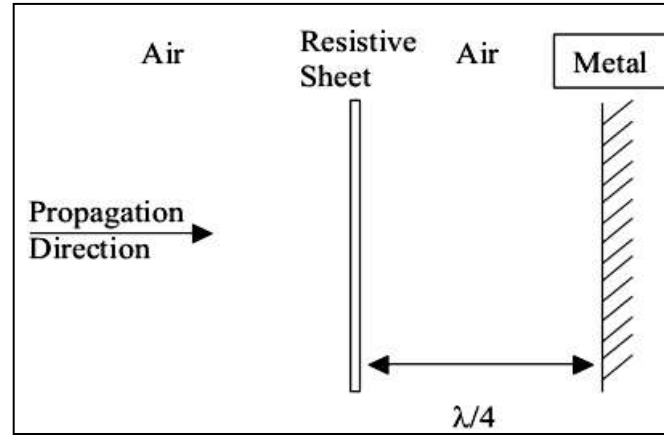


Metode Pelapisan

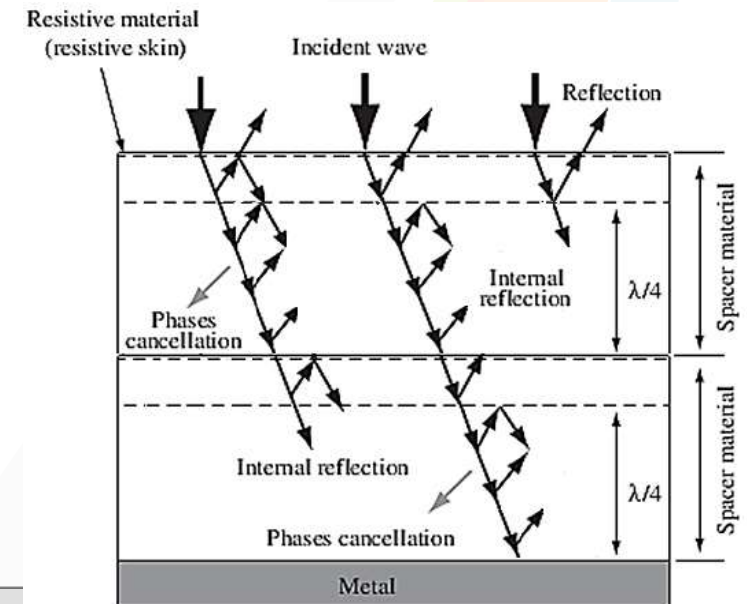
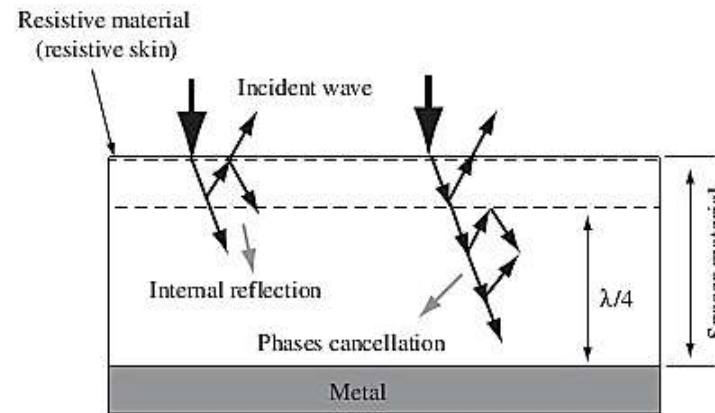
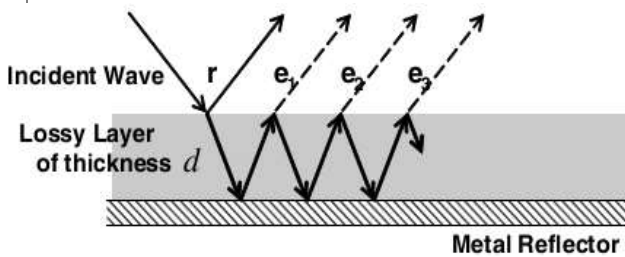
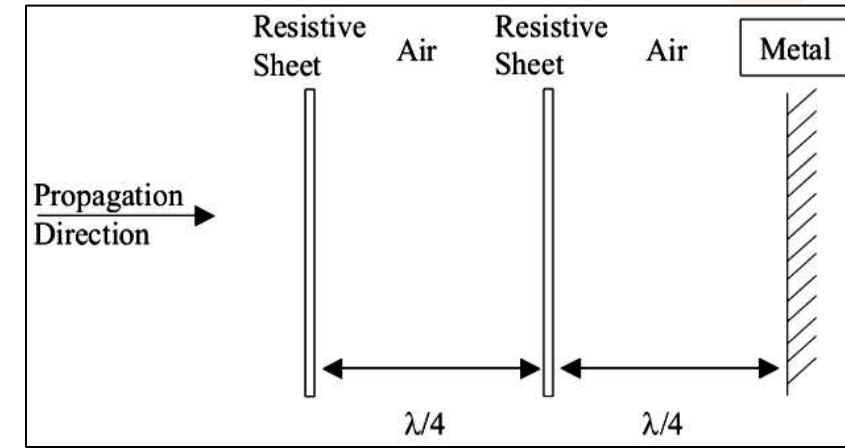
Dallenbach layer



Salisbury Screen



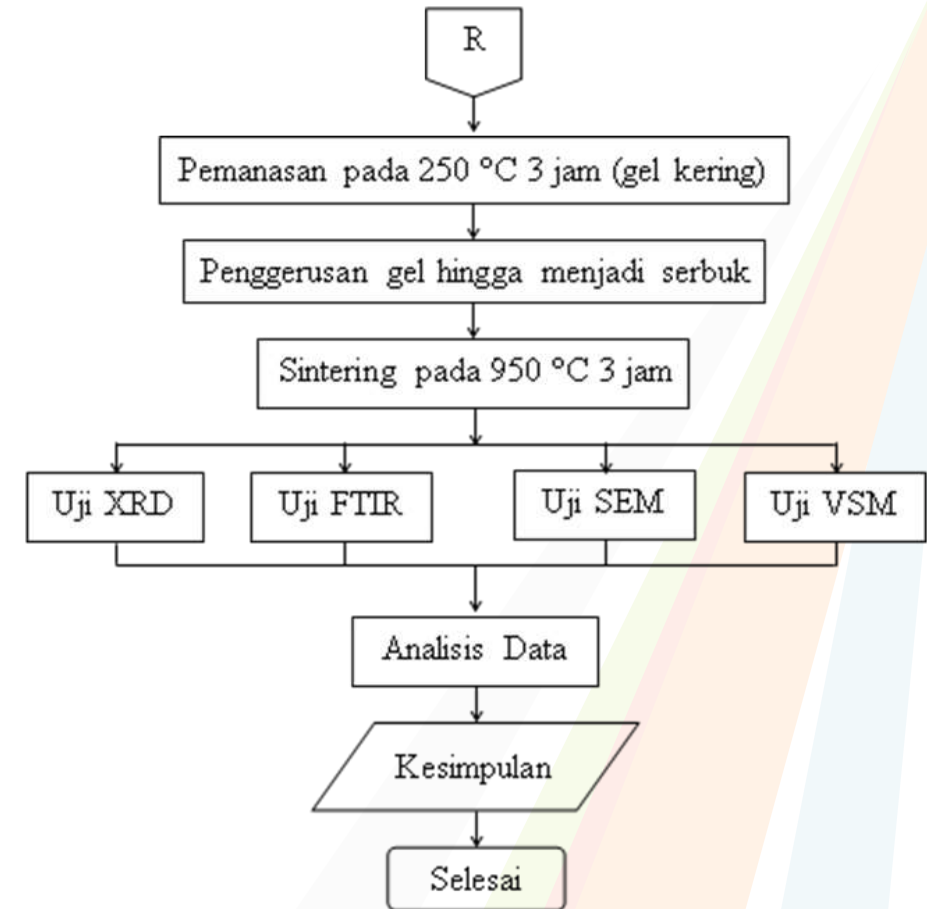
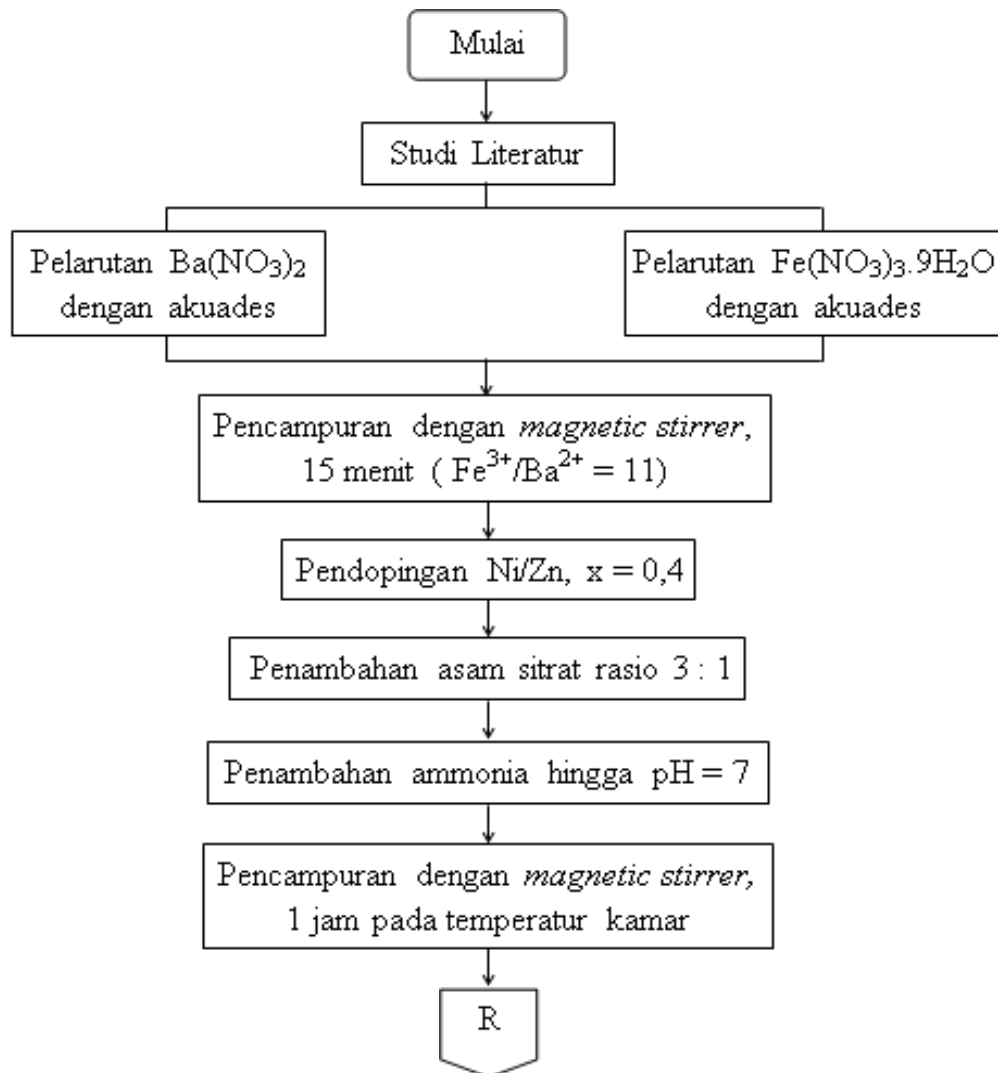
Jaumann Layers





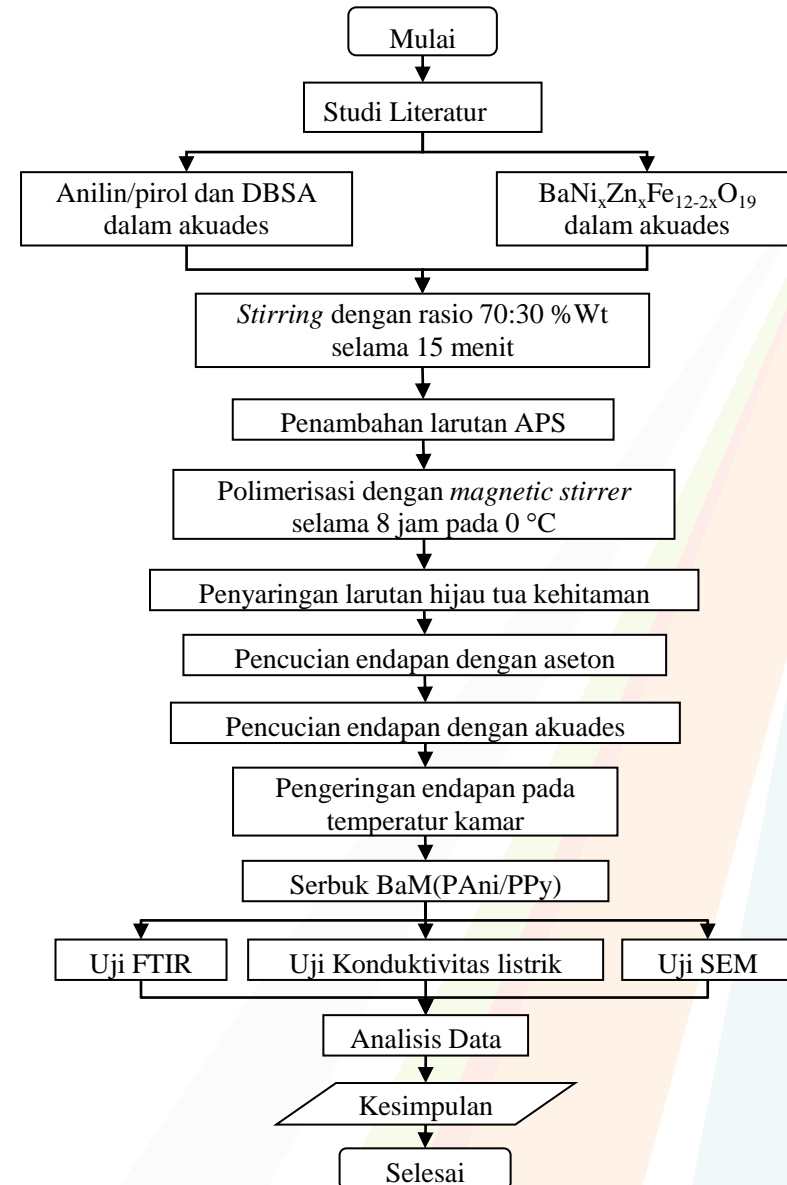
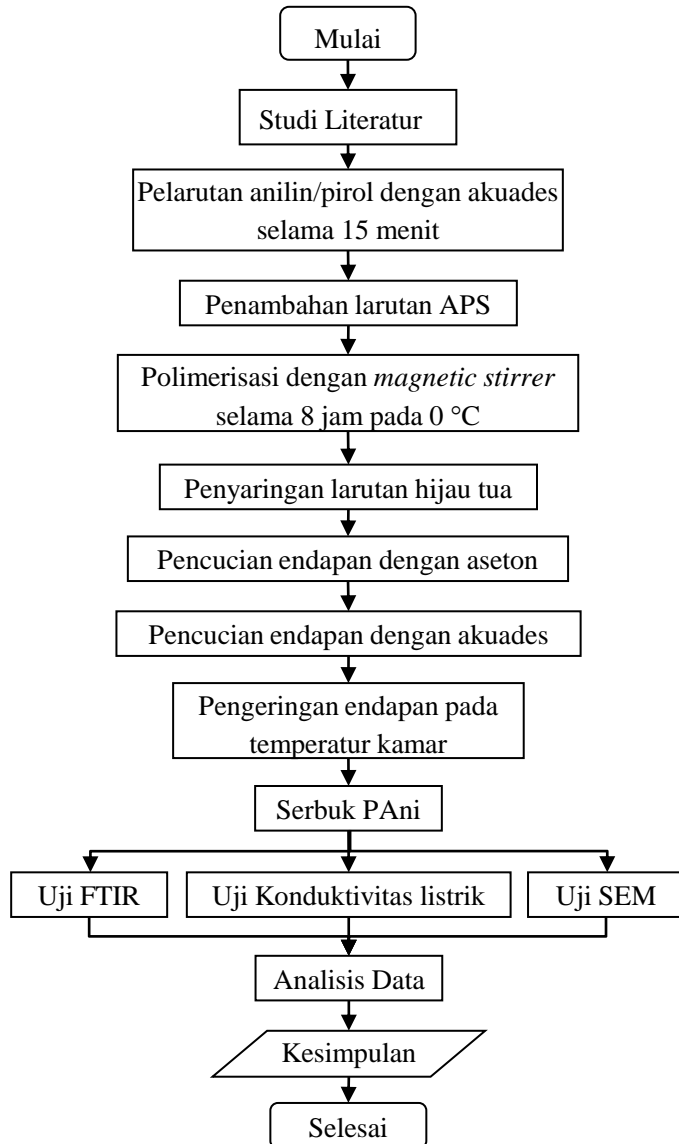
Metode Penelitian

Sintesis $\text{BaNi}_x\text{Zn}_x\text{Fe}_{12-2x}\text{O}_{19}$ dengan Metode Sol Gel



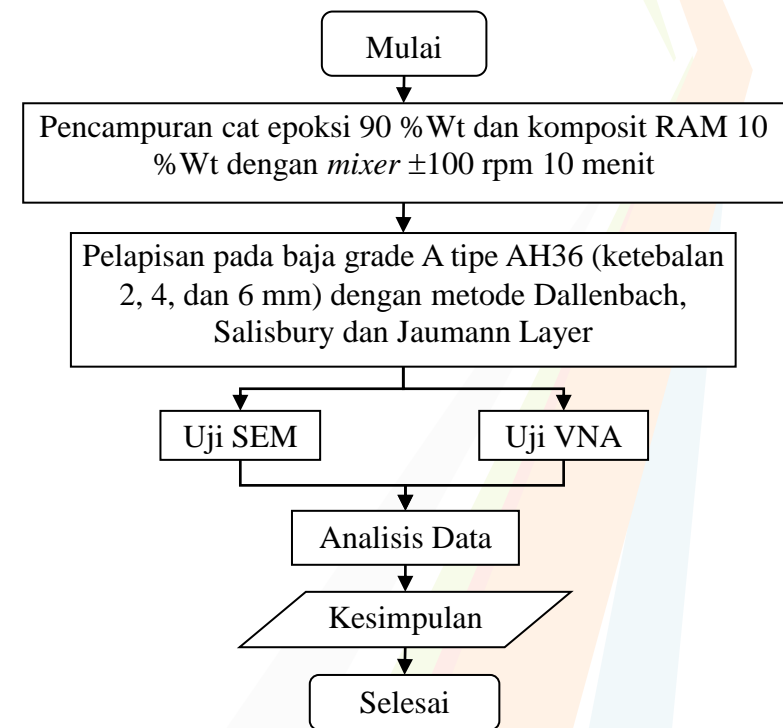
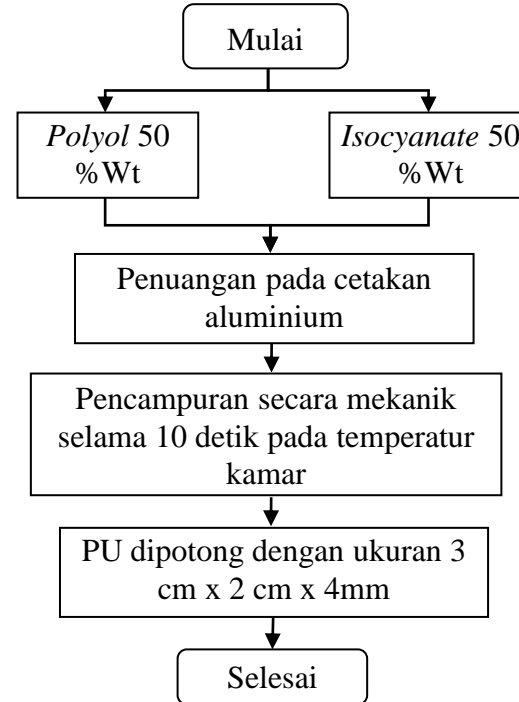
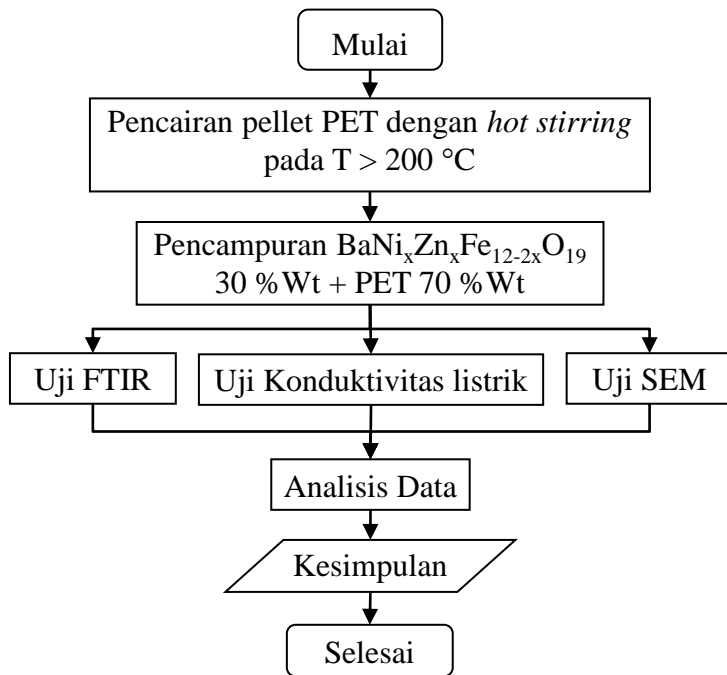


Sintesis Pani, PPy dan komposit BaM/(PAni, PPy)





Sintesis Komposit BaM/PET, Poliuretan (PU) dan Pelapisan Komposit RAM



Spesimen Uji VNA



(BaM/PAni, BaM/PPy, BaM/PET)



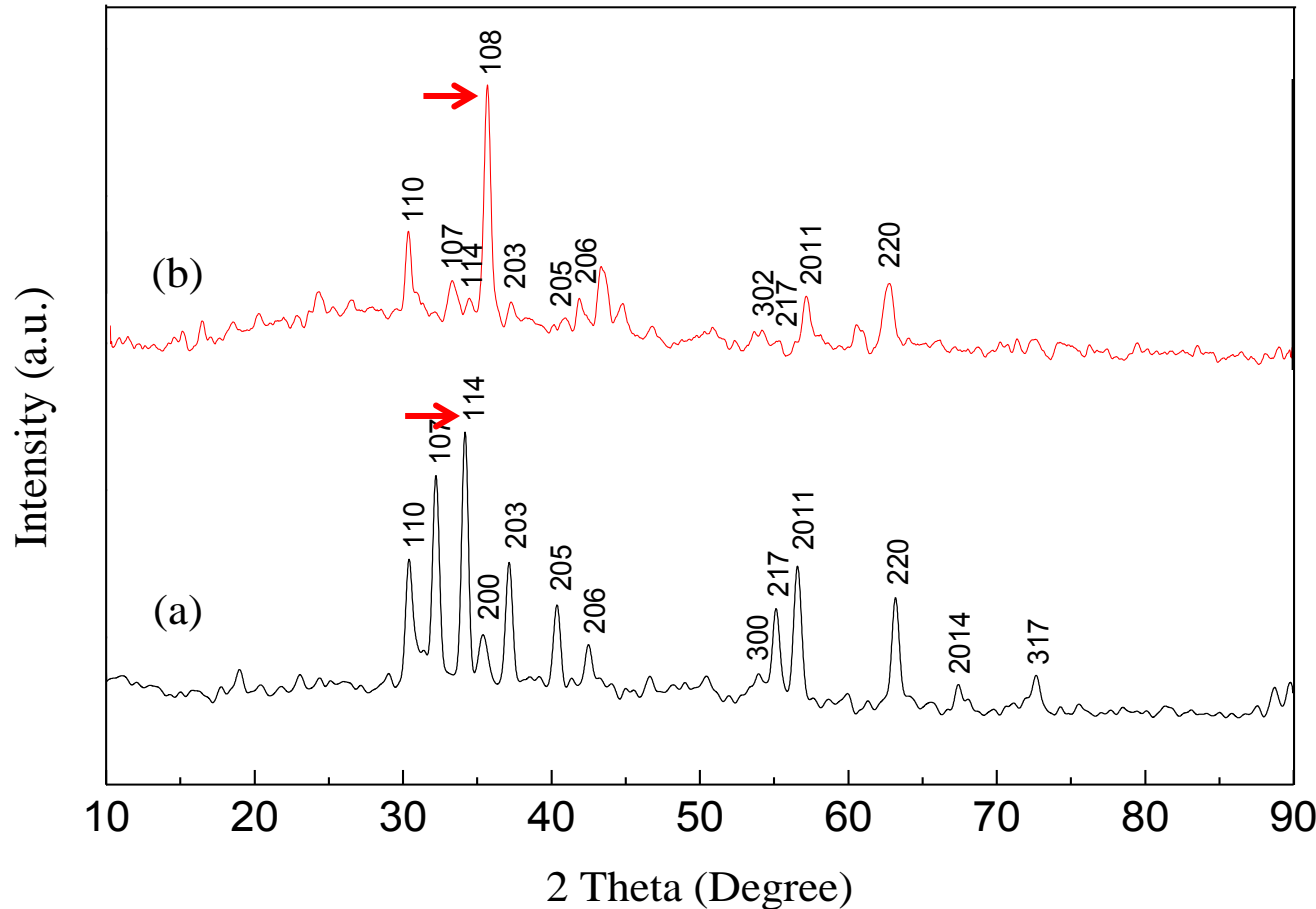
(BaM/PAni Jaumann; 2mm, 4mm, 6mm)



(BaM/PAni 6mm; Dallenbach, Salisbury, Jaumann)



Hasil Pengujian XRD BaM



Material	Indeks Miller Heksagonal
(a) BaFe ₁₂ O ₁₉ (JCPDS 00-043-0002)	(110) (107) (114) (200) (203) (205) (206) (300) (217) (2011) (220) (2014) dan (317)
(b) BaNi _x Zn _x Fe _{12-2x} O ₁₉ (JCPDS 01-074-1121)	(110) (107) (114) (108) (203), (205) (206) (302) (217) (2011) dan (220)

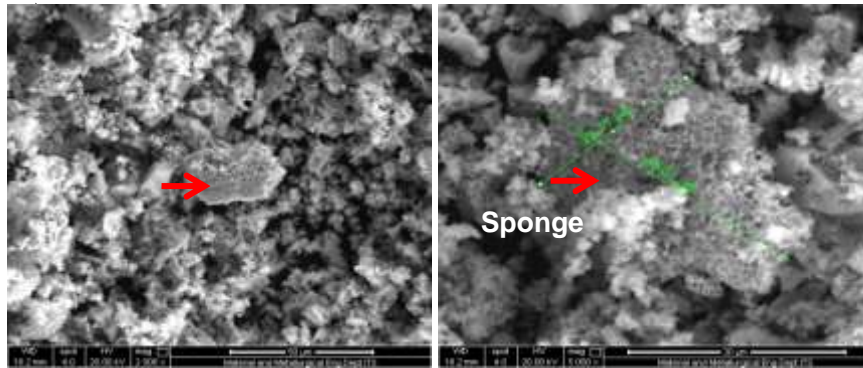
Data Pemandangan : Sharma (2008), Jiang (2009), Kanagesan (2011) dan Xie (2012)

Material	Height (cts)	Pos. [°2Th.]	FWHM Left [°2Th.]	D (nm)	Unit Cell Volume (Å) ³
(a) BaFe ₁₂ O ₁₉	318.30	34.1120	0.1338	122.45	696.99
(b) BaNi _x Zn _x Fe _{12-2x} O ₁₉	232.58	34.1784	0.1338	122.47	697.56

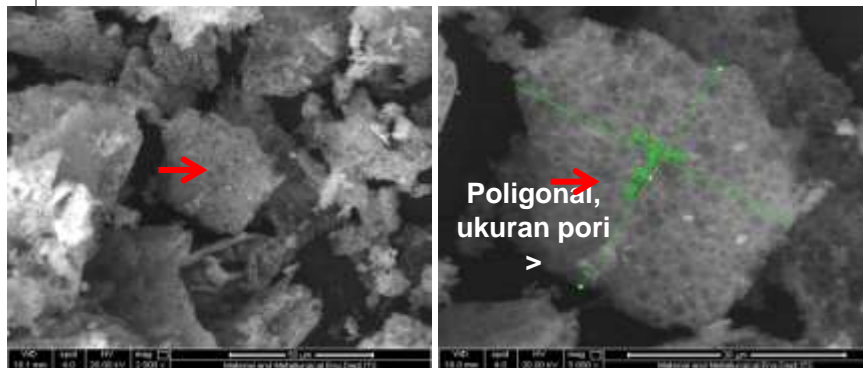
Hasil Pengujian SEM



(a) $\text{BaFe}_{12}\text{O}_{19}$ (BaM no doping) 2000x & 5000x

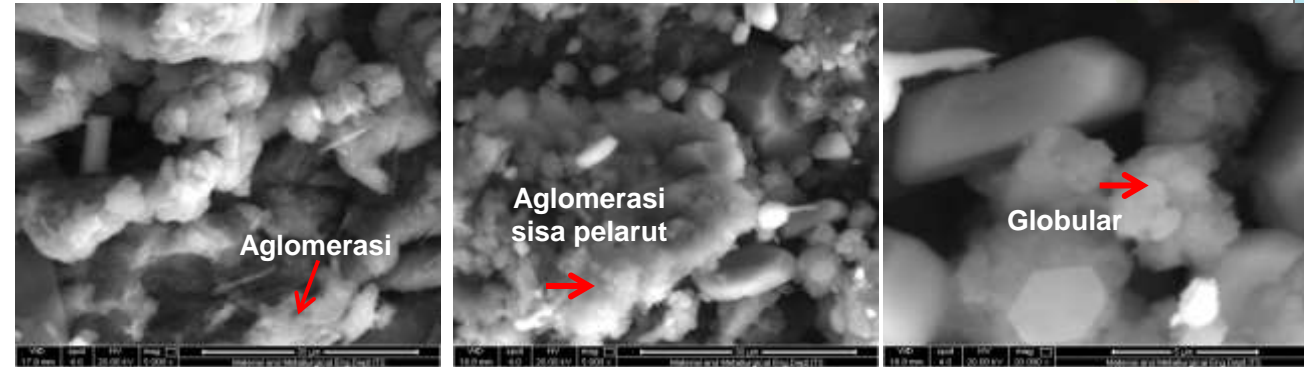


(b) $\text{BaNi}_x\text{Zn}_x\text{Fe}_{12-2x}\text{O}_{19}$ (BaM doping) 2000x & 5000x

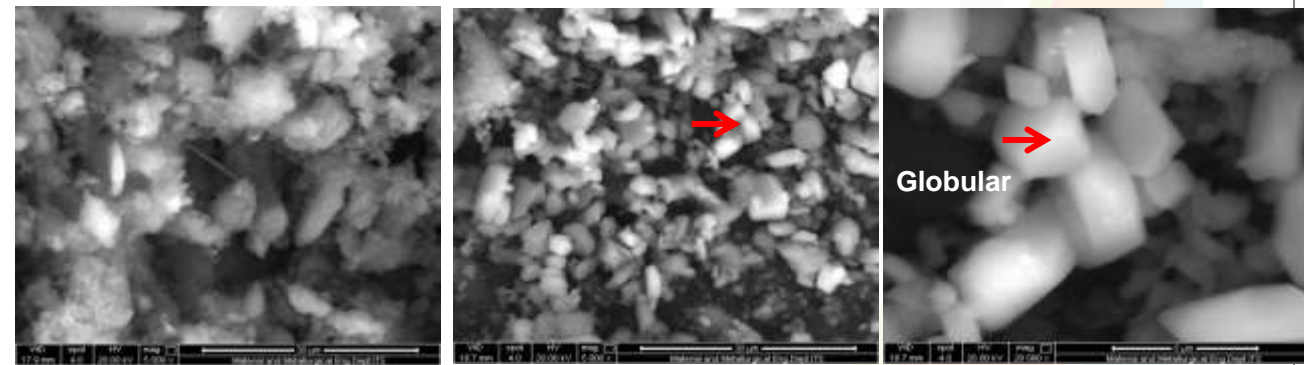


Material	Ukuran pori (μm)
(a) $\text{BaFe}_{12}\text{O}_{19}$	25,71 x 40,07
(b) $\text{BaNi}_x\text{Zn}_x\text{Fe}_{12-2x}\text{O}_{19}$	38,06 x 43,21

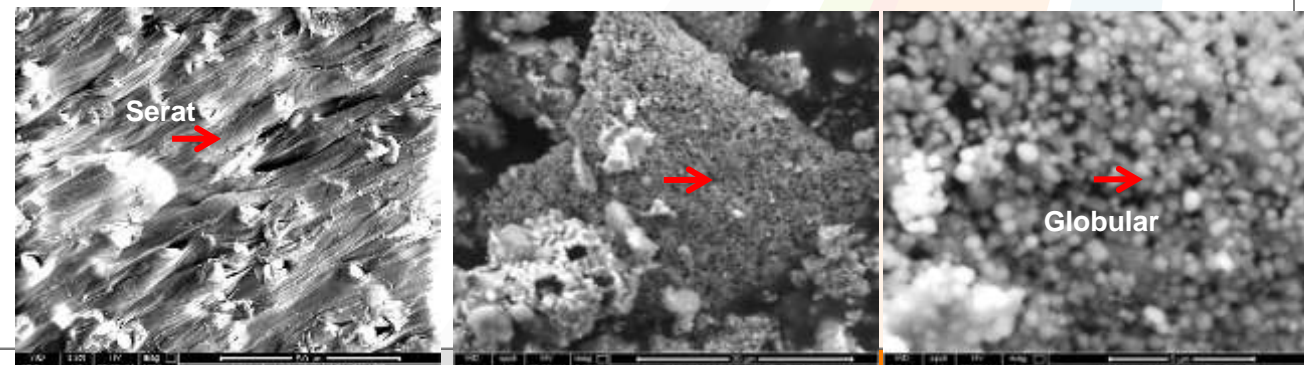
(c) PANi 5000x, BaM/PANi 5000x & 20000x



(d) PPy 5000x, BaM/PPy 5000x & 20000x



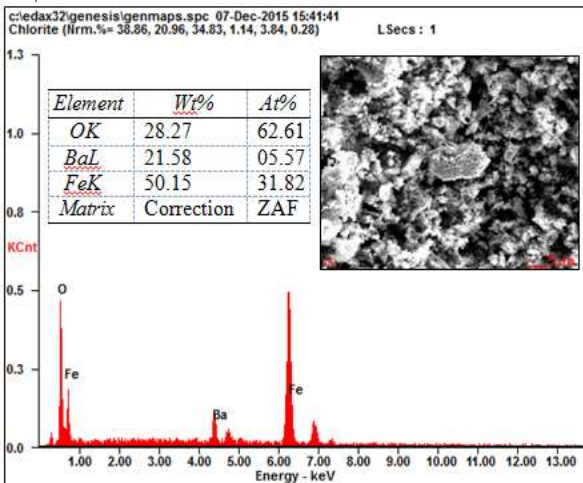
(e) PET 1000x, BaM/PET 5000x & 20000x



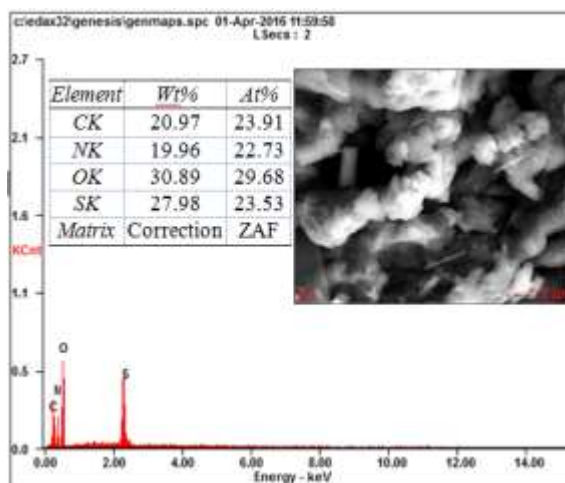
Hasil Pengujian EDAX



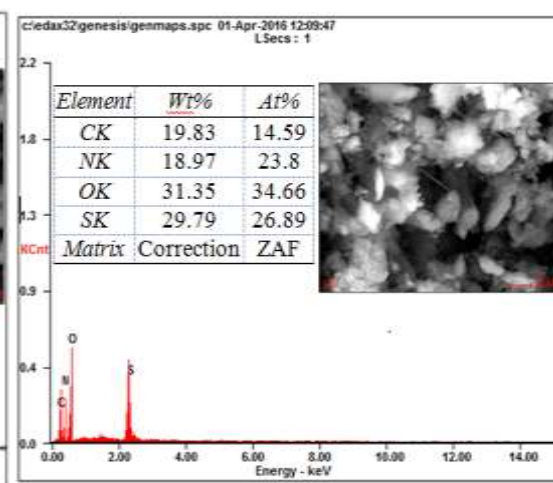
BaFe₁₂O₁₉ 2000x



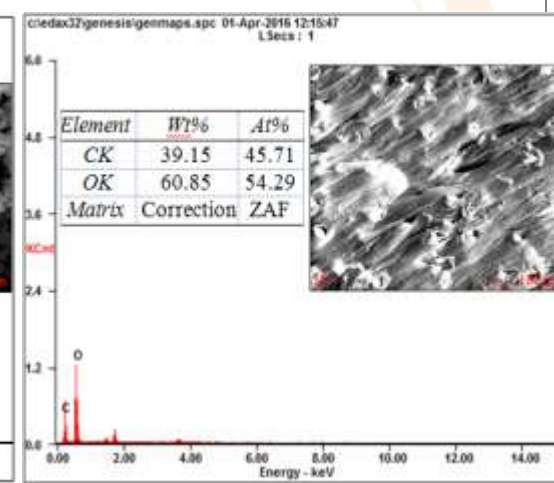
PAni 5000x



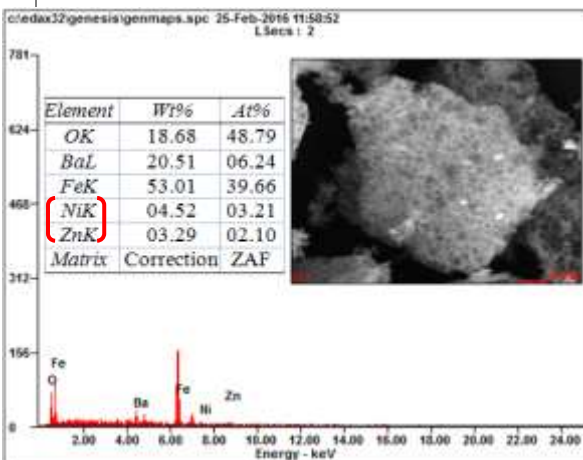
PPy 5000x



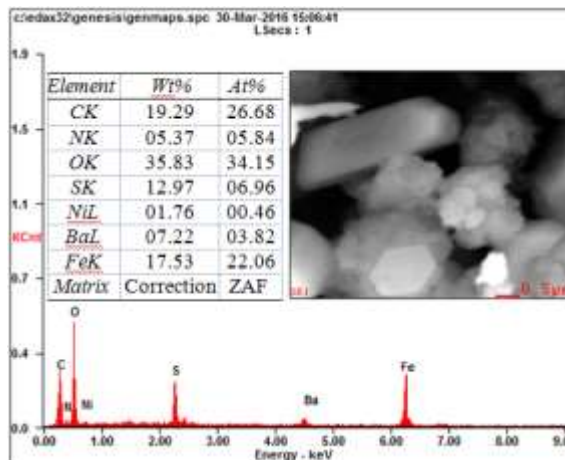
PET 1000x



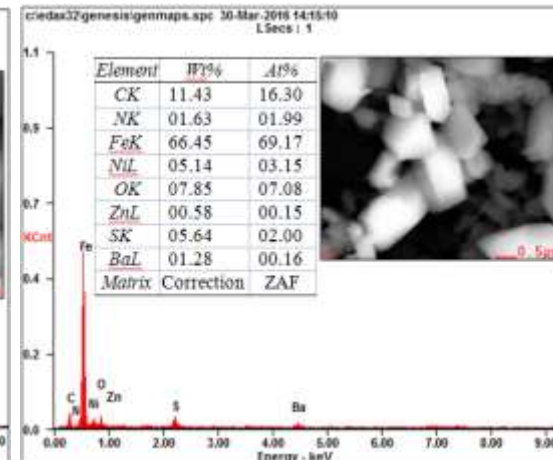
BaNi_xZn_xFe_{12-2x}O₁₉ (BaM) 5000x



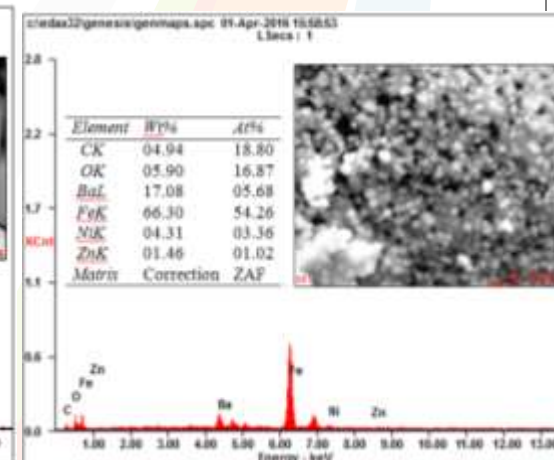
BaM/PAni 20000x



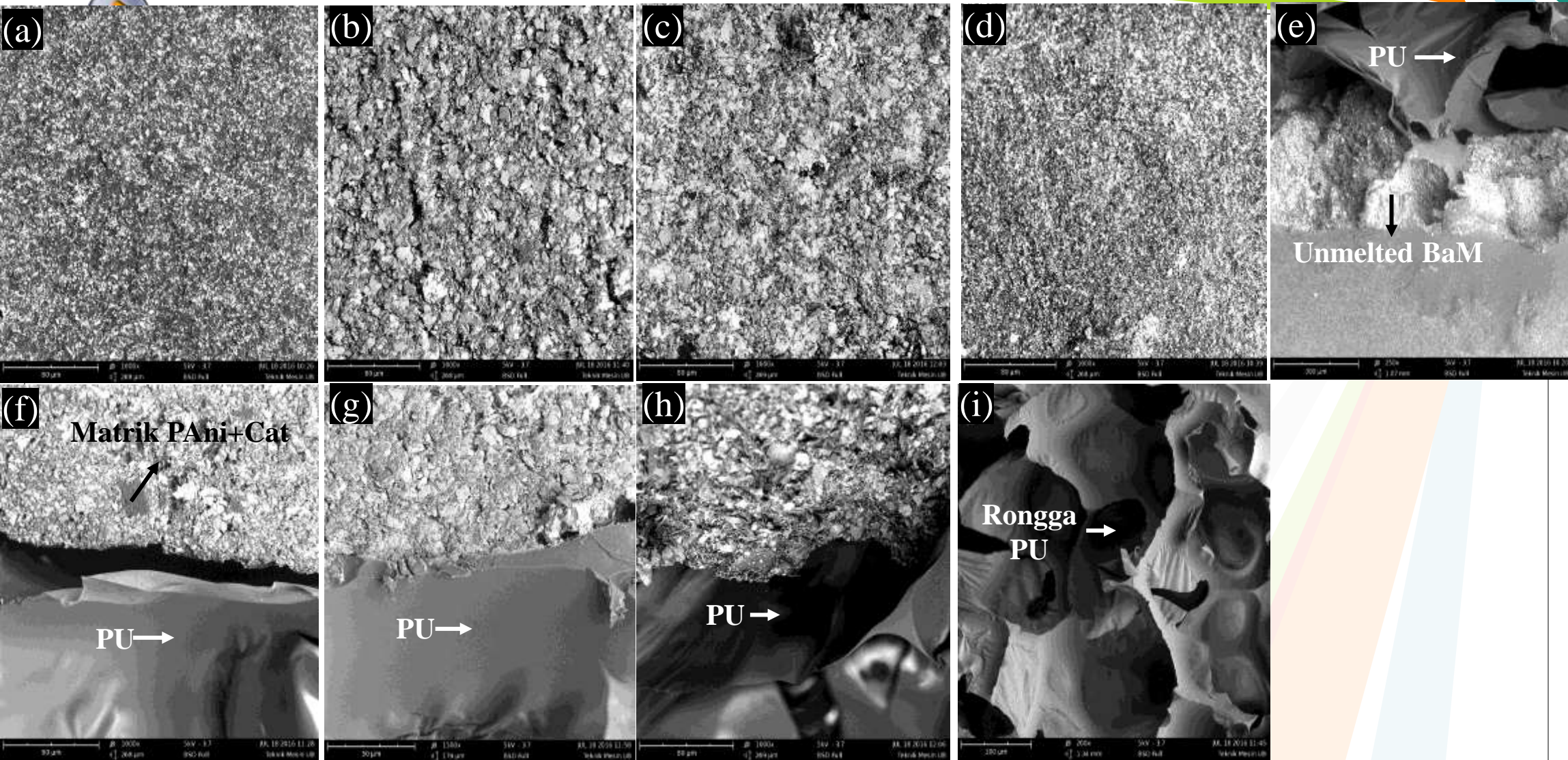
BaM/PPy 20000x



BaM/PET 20000x



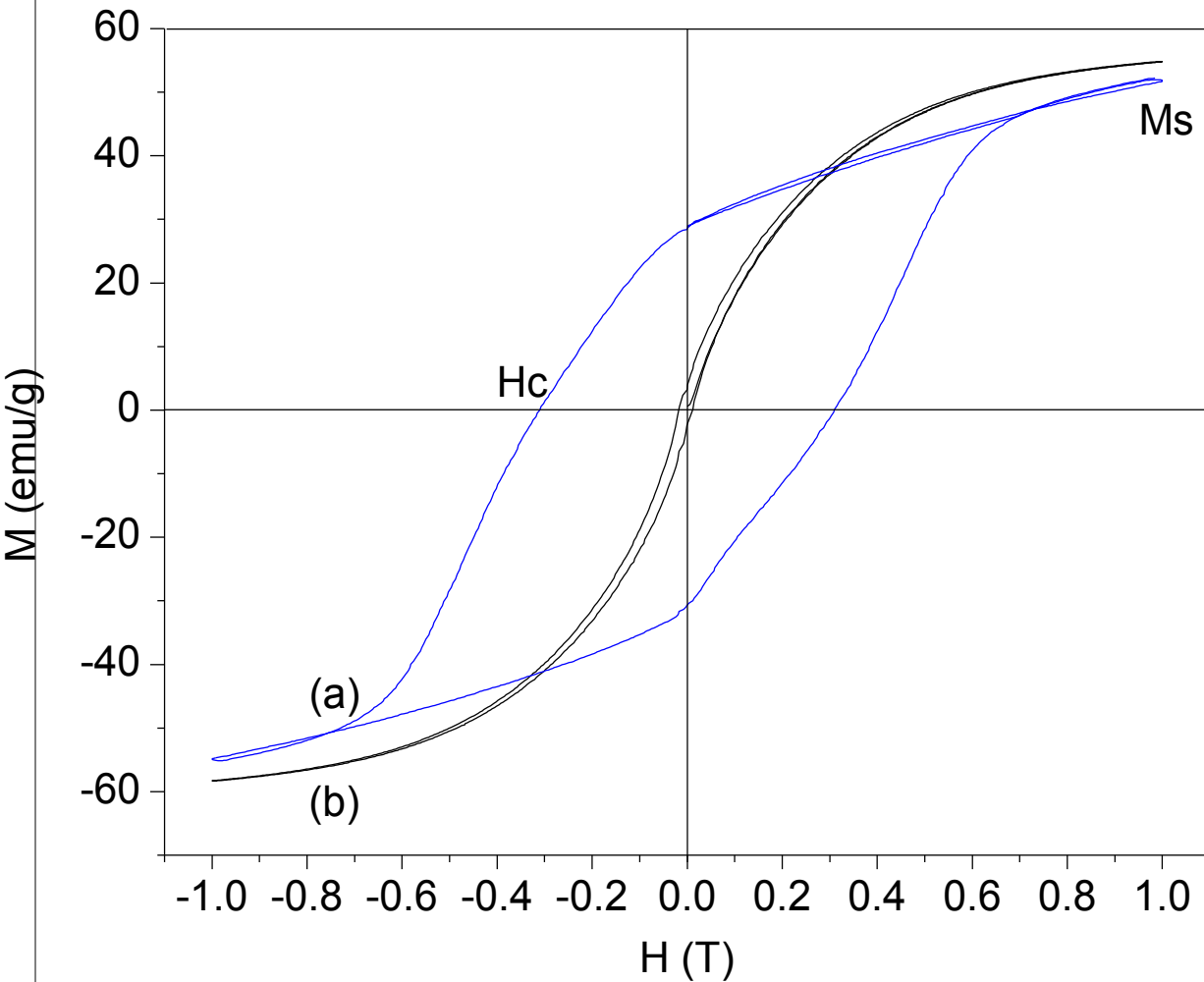
Hasil Pengujian SEM COATING



Hasil SEM coating permukaan atas: (a) BaM/PAni 1000x, (b) BaM/PPy 1000x, dan (c) BaM/PET 1000x
Hasil SEM coating penampang melintang: (d) BaM/PAni *Dallenbach* 1000x, (e) BaM/PAni *Salibury* 250x, (f) BaM/PAni *Jaumann Layer* 1000x, (g) BaM/PPy *Jaumann Layer* 1500x, (h) BaM/PET *Jaumann Layer* 1000x, dan (i) PU 200x



Hasil Pengujian VSM BaM

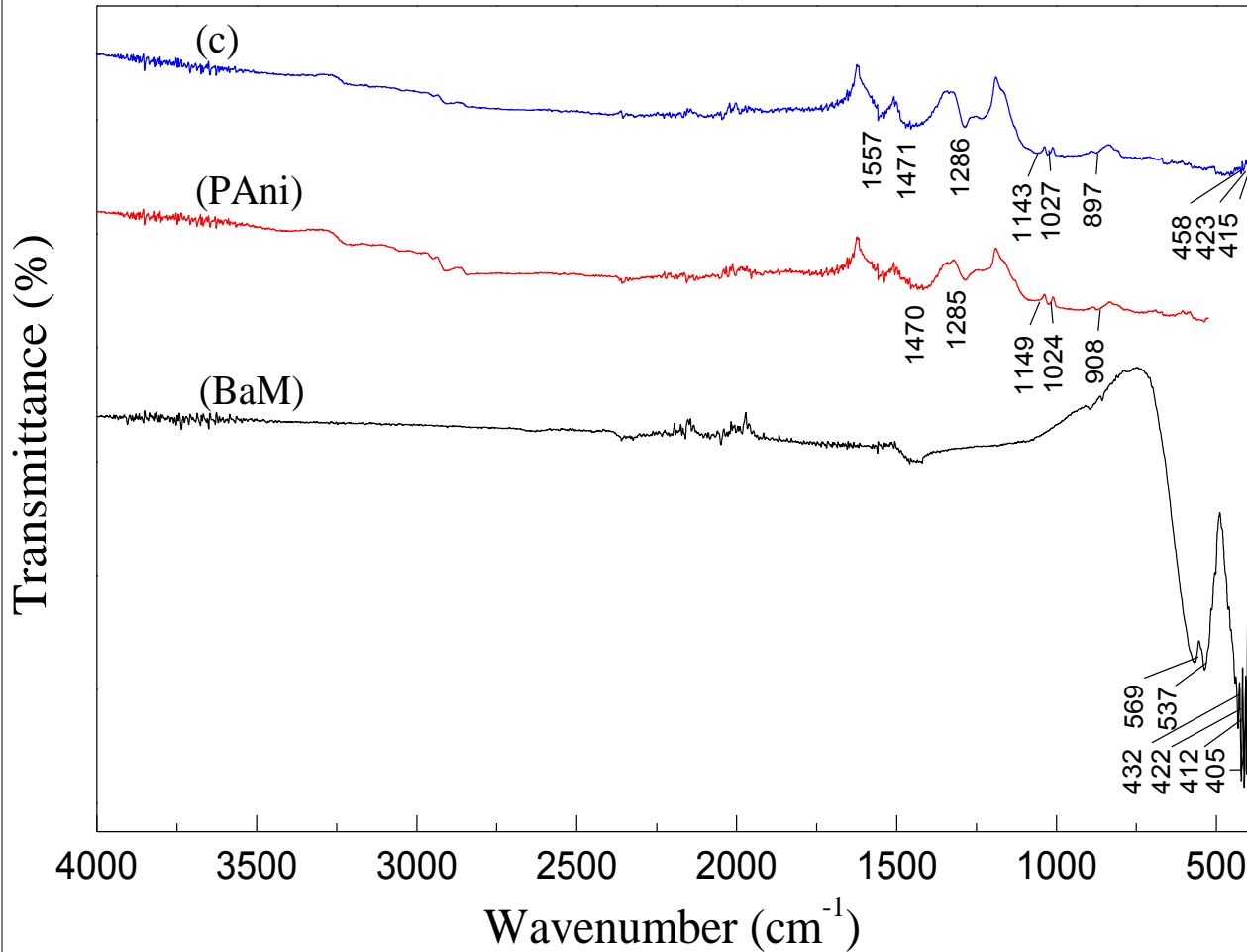


Material	M_s (emu/g)	H_c (Tesla)	H_c (Oe)
(a) $BaFe_{12}O_{19}$	53.5	0.329	13160
(b) $BaNi_xZn_xFe_{12-2x}O_{19}$	56.6	0.0015	60

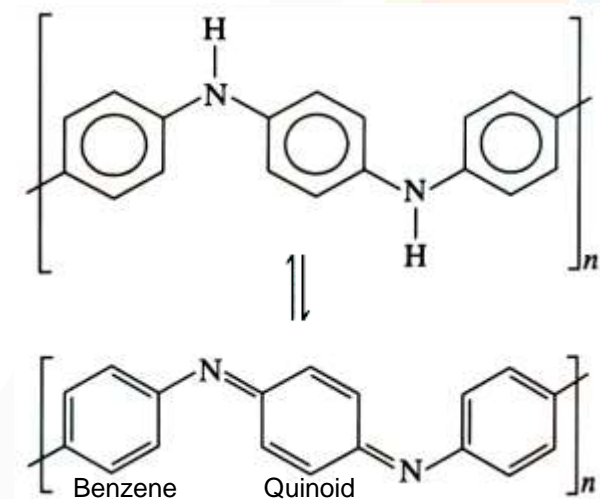
BaM dopingan Ni/Zn bersifat *soft magnetic* karena memiliki nilai M_s dan H_c lebih kecil dibandingkan BaM tanpa doping



Hasil Pengujian FTIR BaM, PAni dan BaM/PAni

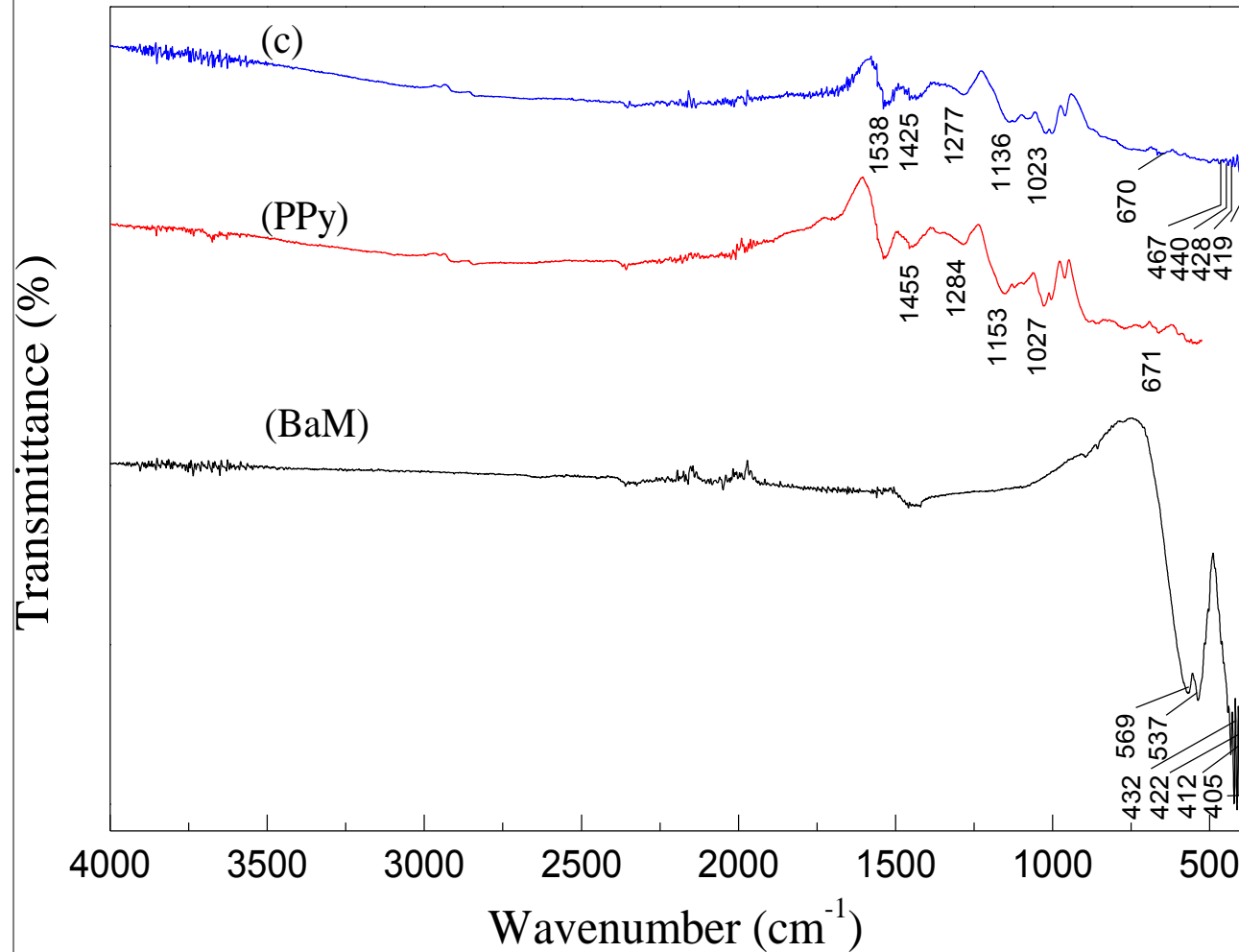


Material	Wave number (cm ⁻¹)	Characteristic peaks
Komposit BaM/PAni	1557	C=C quinoid str
	1470, 1471	C=C benzene str
	1285, 1286	C-N vib
	1149, 1143	S=O str
	1024, 1027	N=Q=N (Q adalah quinoid)
	908, 897	C-H benzene def
BaM	458, 423, 415 (569, 537, 432, 422, 412, 405)	M-O

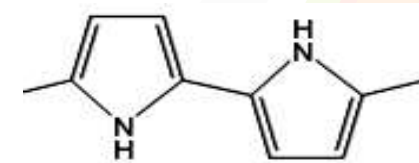




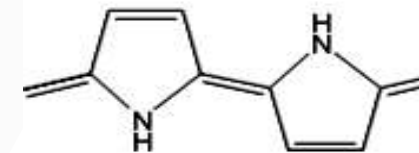
Hasil Pengujian FTIR BaM, PPy dan BaM/PPy



Material	Wave number (cm^{-1})	Characteristic peaks
Komposit BaM/PPy	1538, 1455, 1425	C=C aromatic str
	1284, 1277	C-N vib
	1153, 1136	C-H dan N-H def
	1027, 1023	S=O str (RSO_3H)
	671, 670	C-H benzene def
BaM	467, 440, 428, 419 (569, 537, 432, 422, 412, 405)	M-O



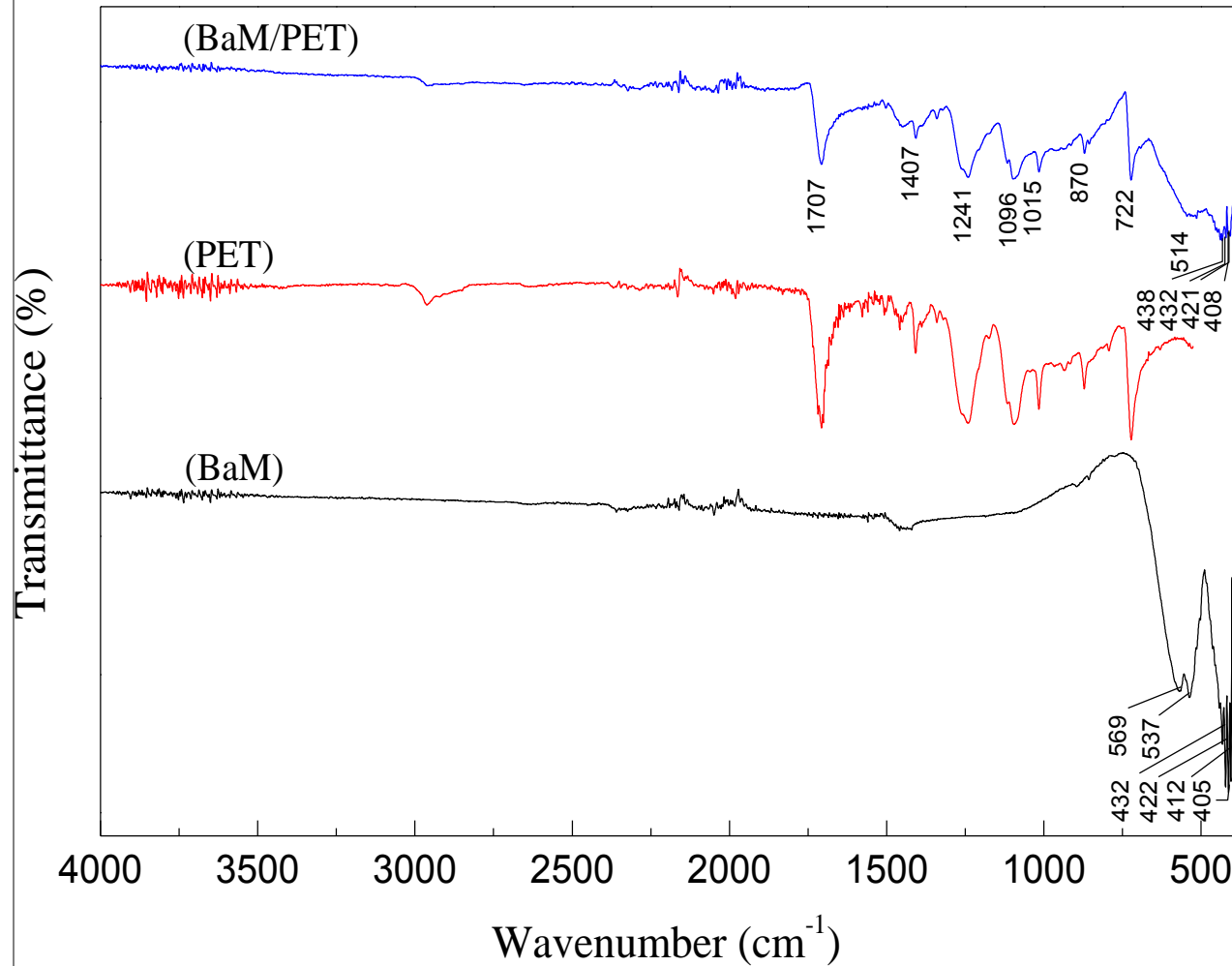
Aromatic



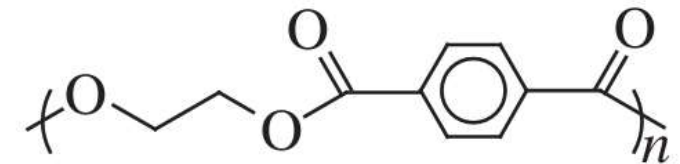
Quinoid



Hasil Pengujian FTIR BaM, PET dan BaM/PET

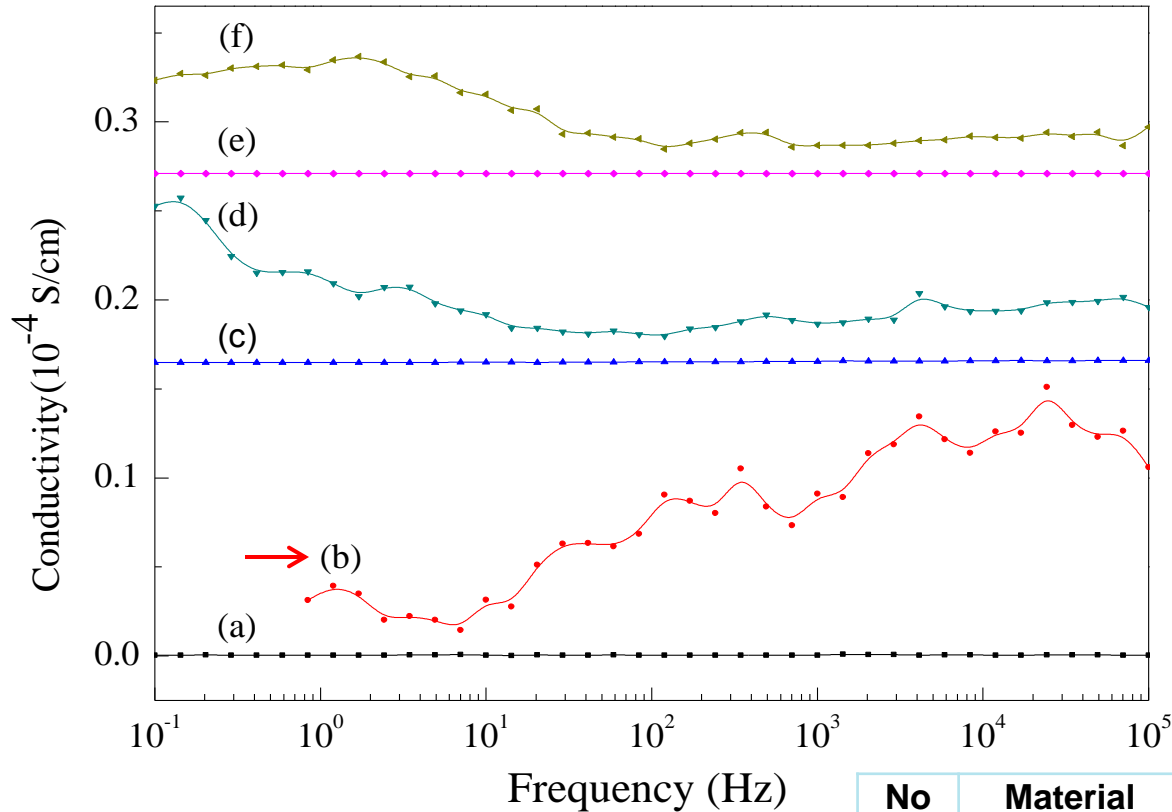


Material	Wave number (cm ⁻¹)	Characteristic peaks
Komposit BaM/PET	1707	C=O str
	1407	C-H ester def
	1241	CH ₃ COOR vib
	1096, 1015	C-O-C str
	870, 722	C-H benzene def
BaM	514, 438, 432, 421, 408	M-O
	(569, 537, 432, 422, 412, 405)	





Hasil Pengujian Konduktivitas Listrik



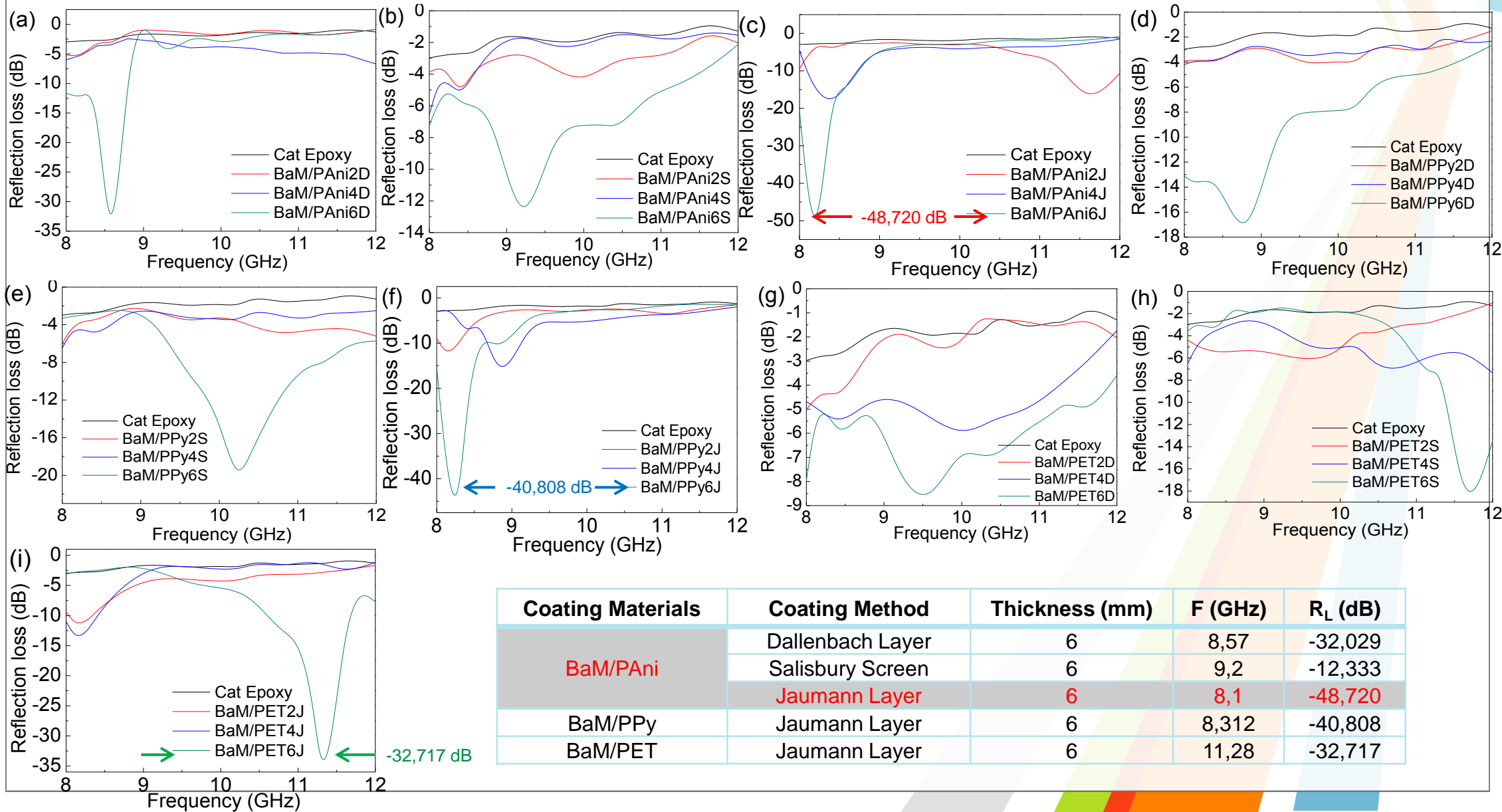
Nilai Konduktivitas Listrik (S/cm)	Sifat Konduktivitas Listrik
10^2 - 10^{-7}	Semikonduktor
$< 10^{-7}$	Dielektrik
$> 10^2$	Konduktor

MacDiarmid, 2001

No	Material	F [Hz]	Kond. Listrik (S/cm)	Sifat Kelistrikan
a.	PAni	1425	8.79809×10^{-8}	Dielektrik
→ b.	BaM/PAni	24240	1.77744×10^{-5}	Semikonduktor
c.	PPy	49240	1.5007×10^{-7}	Semikonduktor
d.	BaM/PPy	0.143	8.68413×10^{-6}	Semikonduktor
e.	PET	170.1	1.47397×10^{-9}	Dielektrik
f.	BaM/PET	1.701	1.0354×10^{-5}	Semikonduktor

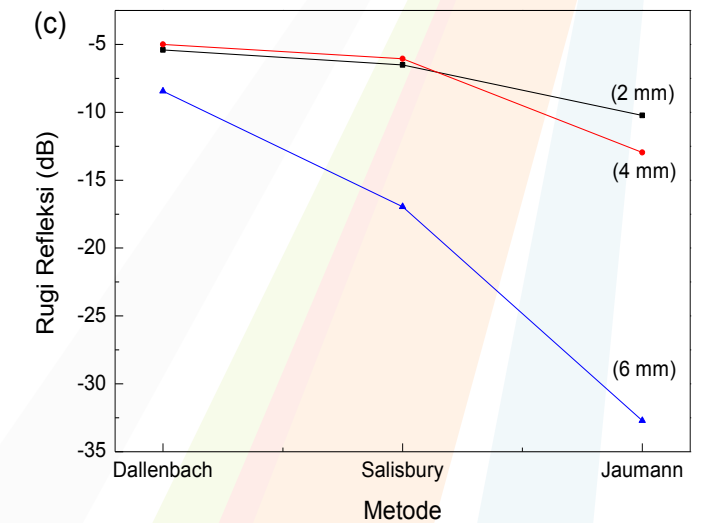
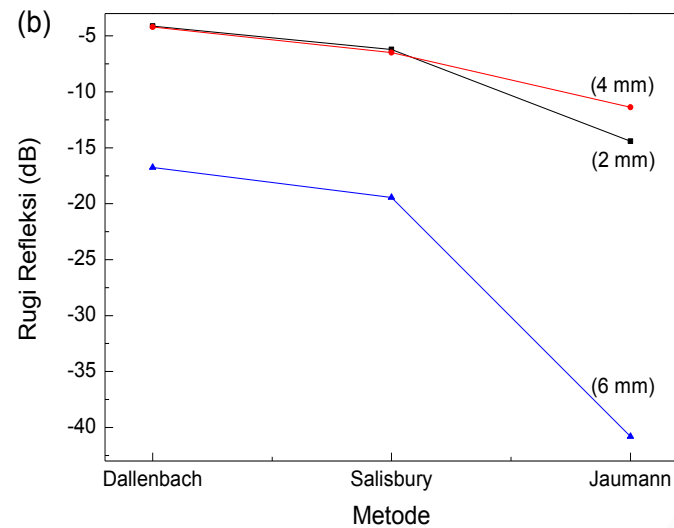
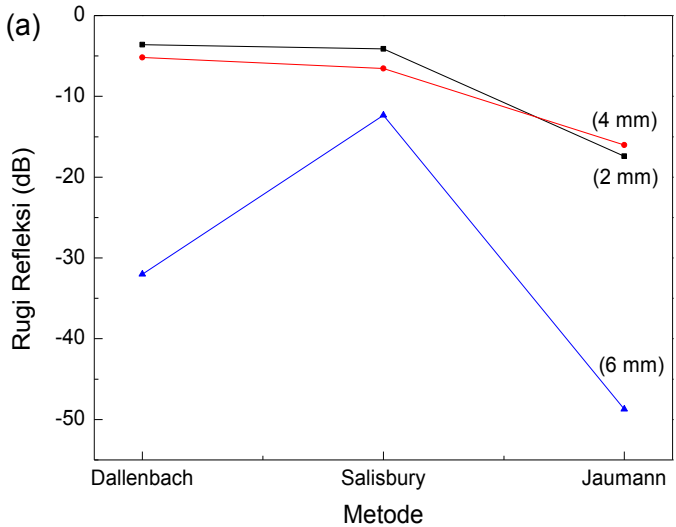
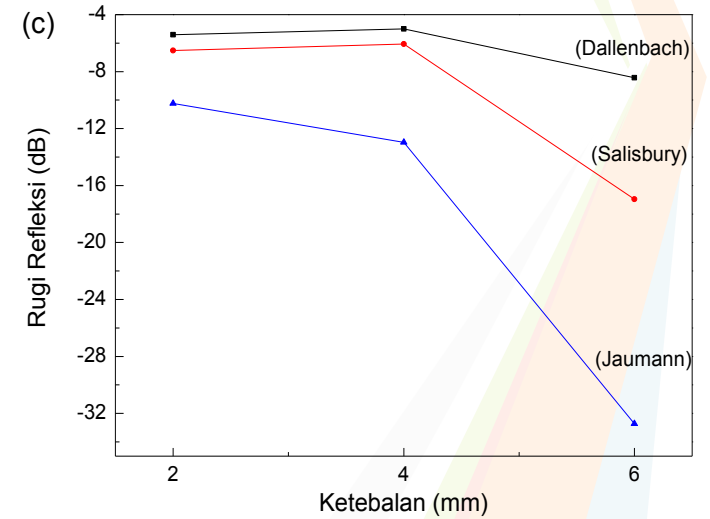
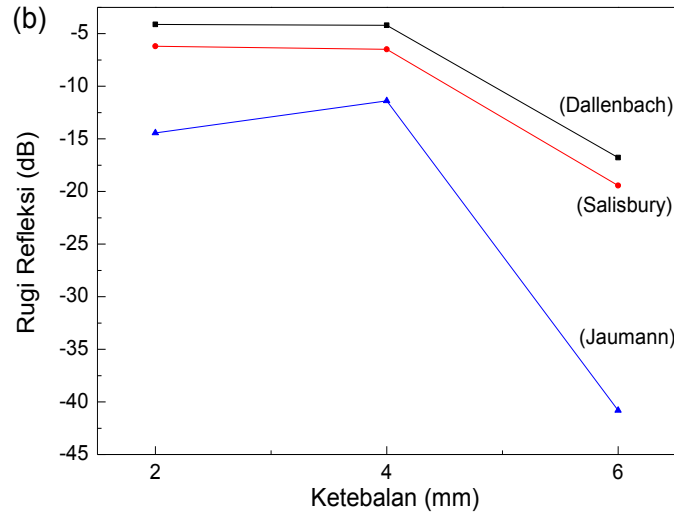
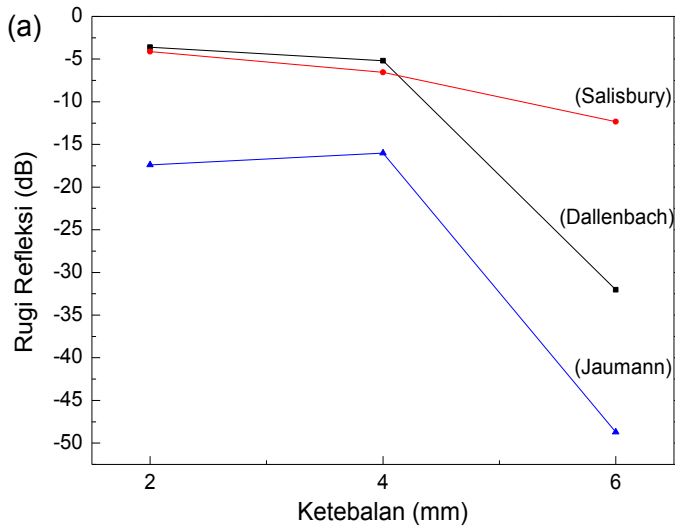


Hasil Pengujian VNA Komposit BaM/(PAni,PPy,PET)





Kurva Trend Pengaruh Ketebalan Lapisan dan Metode Pelapisan terhadap Rugi Refleksi



(a) BaM/PANI, (b) BaM/PPy, (c) BaM/PET



Kesimpulan

1. Absorpsi optimum terhadap gelombang elektromagnetik dimiliki oleh komposit BaM/PAni dengan nilai R_L yaitu -48,720 dB 8,1 GHz, kemudian komposit BaM/PPy -40,808 dB 8,312 GHz dan terakhir komposit BaM/PET -32,717 dB 11,28 GHz. Hal ini terjadi karena komposit BaM/PAni memiliki nilai konduktivitas yang paling tinggi yaitu $1,77744 \times 10^{-5}$ S/m, dibandingkan dengan BaM/PPy dan BaM/PET.
2. Absorpsi optimum terjadi pada lapisan komposit BaM/PAni metode pelapisan Jaumann dengan nilai R_L yaitu -48,720 dB 8,1 GHz. Sedangkan lapisan Dallenbach dan Salisbury memiliki daya absorpsi lebih rendah dibandingkan Jaumann. Hal ini diakibatkan pada lapisan Jaumann memiliki konstruksi lapisan multilayer.
3. Absorpsi optimum terjadi pada lapisan BaM/PAni Jaumann ketebalan 6 mm dengan nilai R_L yaitu -48,720 dB 8,1 GHz. Hal ini disebabkan saat lapisan material semakin tebal, maka partikel-partikel penyerap dan luas penyerapan di dalam lapisan tersebut juga akan bertambah. Akibatnya proses penyerapannya akan semakin meningkat.



Thank You!