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Supporting Information

Transition Metal Ions Induced Secondary Structural Transformation in Hydrophobized Short Peptide Amphiphile

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Material and methods

1.0 General- Dichloromethane, *N,N*-dimethylformamide, methanolwere distilled following standard procedures prior to use. Palmitic acid, L-Phenylalanine, β-alanine, Trifluoroacetic acid, Hydrochloric acid, *N*-hydroxybenzotriazole, *tert*-butyloxycarbonyl carbonate, sodium hydroxide, diethyl ether, EDC.HCl, DIPEAwere purchased from Spectrochem, Mumbai, India, and used without further purification. $Fe(NO_3)_3.9H_2O$, $Co(NO_3)_2.6H_2O$, $Ni(NO_3)_2.6H_2O$, $Cu(NO_3)_2.3H_2O$ and $Zn(NO_3)_2.6H_2O$ metal salts purchased from Himedia Laboratories Pvt. Ltd., Mumbai, India. ^1H and ^{13}C NMR spectra were recorded on JEOL-JNM LAMBDA 500 model operating at 500 and 125 MHz, respectively. HRMS mass spectra were recorded at IIT Kanpur, India, on Waters, Q-Tof Premier micromass HAB 213 mass spectrometer using capillary voltage 2.6-3.2 kV.

2.0 FT-IR Study- FT-IR spectra of sPA alone and sPA-metal ions were performed in the range of 4000$cm^{-1}$to 500cm^{-1} using Bruker Alfa II ATR, FTIR spectrometer. Spectra were proceesessed; base line correction and smoothed using OPUS 7.0 software and removed unwanted noise.

3.0 FTIR data analysis: For decomposition of FT-IR spectra the second derivative spectra of the processed FT-IR spectra were obtained following the Savitsky–Golay method using origin software. Now, amides I band from 1700 to 1600 cm−1 were deconvolated using multiple Gaussian peaks fitting using origin software. In the fitting, the numbers of initial peak values were taken from the second derivative spectrum. The contribution of each component was calculated by measuring area of the curve of each component.[1–5]

4.0 Computational Details-All calculations were performed using the ORCA quantum chemical program package[6]. Geometries were optimized with the GGA (generalized gradient approximation) density functional BLYP[7-9] in conjunction with def2-SVP[10] basis sets. To accelerate the overall calculations, the RI[11-14] (resolution-of-identity) approximation was applied for the expensive integral calculations. Noncovalent interactions were accounted by using atom-pairwise dispersion corrections with Becke-Johnson (D3BJ) damping.[14] Subsequent numerical frequency calculations were undertaken for the optimized geometries to confirm that they correspond to stationary points featuring no imaginary frequencies. Binding energies are calculated by single point calculations with BLYP/def2-TZVP[10]/C-PCM[15](EtOH) method on the BLYP/def2-SVP geometries.

XYZ coordinates for the optimized Geometries with BLYP-D3/def-SVP

Peptide Model (L)

C	-2.410880000	-0.989100000	0.451833000
H	-2.007375000	-0.363668000	-0.372424000
C	-3.210929000	-0.105812000	1.419268000
O	-2.885405000	0.045538000	2.598167000
N	-4.311786000	0.527532000	0.868222000
H	-4.632385000	0.217098000	-0.053215000
C	-5.306733000	1.142573000	1.725570000
H	-4.779082000	1.375273000	2.674488000
C	-6.397335000	0.095748000	2.105566000
O	-6.257151000	-1.108468000	1.881868000
N	-7.501077000	0.574827000	2.772851000

H	-7.587378000	1.574720000	2.951401000
C	-8.525956000	-0.329718000	3.292618000
H	-8.027204000	-1.272907000	3.585585000
H	-8.969225000	0.127911000	4.198117000
C	-9.663311000	-0.654429000	2.285221000
H	-10.142467000	0.274495000	1.925374000
H	-10.422129000	-1.265082000	2.815336000
C	-9.173038000	-1.431497000	1.070222000
O	-9.030788000	-0.968736000	-0.049887000
O	-8.898116000	-2.725862000	1.384748000
H	-8.487371000	-3.124864000	0.585384000
C	-5.838284000	2.465911000	1.101662000
H	-6.616519000	2.905647000	1.759258000
H	-4.995088000	3.183992000	1.099425000
C	-6.376039000	2.304906000	-0.310632000
C	-5.534067000	2.529722000	-1.424121000
C	-7.703222000	1.885199000	-0.543259000
C	-6.014110000	2.361223000	-2.734065000
C	-8.185489000	1.713558000	-1.851948000
C	-7.345059000	1.960786000	-2.950978000
H	-4.492803000	2.840970000	-1.256351000
H	-8.363935000	1.670665000	0.305262000
H	-5.344663000	2.537337000	-3.587974000
H	-9.216196000	1.365273000	-2.003954000
H	-7.720980000	1.824915000	-3.975363000
C	-3.213069000	-2.183089000	-0.153130000
H	-2.471126000	-2.925102000	-0.514633000
H	-3.790601000	-2.673068000	0.655148000
C	-4.140703000	-1.816554000	-1.303562000
C	-3.611271000	-1.487996000	-2.573749000
C	-5.543168000	-1.762898000	-1.127336000
C	-4.457785000	-1.122151000	-3.635091000
C	-6.392733000	-1.384591000	-2.183681000
C	-5.851288000	-1.068257000	-3.441956000
H	-2.522057000	-1.527396000	-2.733357000
H	-5.964111000	-1.983521000	-0.138410000
H	-4.027401000	-0.874463000	-4.616885000
H	-7.473229000	-1.316856000	-1.998410000
H	-6.511236000	-0.768093000	-4.267934000
H	-1.554201000	-1.368362000	1.038054000

Fe-peptide Model

C	-2.186790000	-0.815838000	0.582713000
H	-1.780428000	-0.041704000	-0.096980000
C	-3.449245000	-0.316909000	1.268582000
O	-4.204720000	-1.077119000	1.898703000
N	-3.839930000	0.988200000	1.059206000
H	-3.154719000	1.681163000	0.743416000

C	-5.058551000	1.459303000	1.719194000
H	-4.864472000	1.681565000	2.790682000
C	-6.100859000	0.336386000	1.638596000
O	-6.288440000	-0.268838000	0.510796000
N	-6.990598000	0.132638000	2.604801000
H	-6.830666000	0.559893000	3.525443000
C	-8.097868000	-0.842510000	2.468207000
H	-7.679275000	-1.797023000	2.097011000
H	-8.480842000	-1.027507000	3.485949000
C	-9.286027000	-0.333628000	1.570236000
H	-9.181413000	0.755190000	1.398008000
H	-10.234465000	-0.489515000	2.116419000
C	-9.458433000	-0.997844000	0.212701000
O	-8.735715000	-0.796424000	-0.808520000
O	-10.483488000	-1.805822000	0.151174000
H	-10.617536000	-2.201846000	-0.747351000
C	-5.615316000	2.776916000	1.054425000
H	-6.236126000	3.296333000	1.808043000
H	-4.750518000	3.443431000	0.856892000
C	-6.429357000	2.566026000	-0.209556000
C	-5.824255000	2.132776000	-1.428683000
C	-7.837682000	2.756634000	-0.190730000
C	-6.621224000	1.863083000	-2.580174000
C	-8.633478000	2.473500000	-1.321147000
C	-8.034949000	1.996477000	-2.514590000
H	-4.731745000	2.040347000	-1.496028000
H	-8.316114000	3.146866000	0.719923000
H	-6.140301000	1.627039000	-3.539863000
H	-9.720846000	2.633633000	-1.282964000
H	-8.650522000	1.790217000	-3.402617000
C	-2.483495000	-2.155584000	-0.167094000
H	-1.619078000	-2.372910000	-0.829908000
H	-2.552791000	-2.980040000	0.564605000
C	-3.753307000	-2.093286000	-0.987335000
C	-3.881731000	-1.168681000	-2.065559000
C	-4.863576000	-2.923889000	-0.676874000
C	-5.073029000	-1.082869000	-2.819788000
C	-6.066306000	-2.834432000	-1.401168000
C	-6.194421000	-1.902381000	-2.480063000
H	-3.019631000	-0.550890000	-2.357138000
H	-4.774974000	-3.653891000	0.139894000
H	-5.100514000	-0.459835000	-3.724509000
H	-6.905265000	-3.501670000	-1.156589000
H	-7.059328000	-1.968297000	-3.163118000
Fe	-6.901085000	-0.132622000	-1.251972000
H	-1.412970000	-1.009627000	1.354016000

Cu-peptide Model

C	-2.186790000	-0.815838000	0.582713000
H	-1.780428000	-0.041704000	-0.096980000
C	-3.449245000	-0.316909000	1.268582000
O	-4.204720000	-1.077119000	1.898703000
N	-3.839930000	0.988200000	1.059206000
H	-3.154719000	1.681163000	0.743416000
C	-5.058551000	1.459303000	1.719194000
H	-4.864472000	1.681565000	2.790682000
C	-6.100859000	0.336386000	1.638596000
O	-6.288440000	-0.268838000	0.510796000
N	-6.990598000	0.132638000	2.604801000
H	-6.830666000	0.559893000	3.525443000
C	-8.097868000	-0.842510000	2.468207000
H	-7.679275000	-1.797023000	2.097011000
H	-8.480842000	-1.027507000	3.485949000
C	-9.286027000	-0.333628000	1.570236000
H	-9.181413000	0.755190000	1.398008000
H	-10.234465000	-0.489515000	2.116419000
C	-9.458433000	-0.997844000	0.212701000
O	-8.735715000	-0.796424000	-0.808520000
O	-10.483488000	-1.805822000	0.151174000
H	-10.617536000	-2.201846000	-0.747351000
C	-5.615316000	2.776916000	1.054425000
H	-6.236126000	3.296333000	1.808043000
H	-4.750518000	3.443431000	0.856892000
C	-6.429357000	2.566026000	-0.209556000
C	-5.824255000	2.132776000	-1.428683000
C	-7.837682000	2.756634000	-0.190730000
C	-6.621224000	1.863083000	-2.580174000
C	-8.633478000	2.473500000	-1.321147000
C	-8.034949000	1.996477000	-2.514590000
H	-4.731745000	2.040347000	-1.496028000
H	-8.316114000	3.146866000	0.719923000
H	-6.140301000	1.627039000	-3.539863000
H	-9.720846000	2.633633000	-1.282964000
H	-8.650522000	1.790217000	-3.402617000
C	-2.483495000	-2.155584000	-0.167094000
H	-1.619078000	-2.372910000	-0.829908000
H	-2.552791000	-2.980040000	0.564605000
C	-3.753307000	-2.093286000	-0.987335000
C	-3.881731000	-1.168681000	-2.065559000
C	-4.863576000	-2.923889000	-0.676874000
C	-5.073029000	-1.082869000	-2.819788000
C	-6.066306000	-2.834432000	-1.401168000
C	-6.194421000	-1.902381000	-2.480063000
H	-3.019631000	-0.550890000	-2.357138000
H	-4.774974000	-3.653891000	0.139894000
H	-5.100514000	-0.459835000	-3.724509000
H	-6.905265000	-3.501670000	-1.156589000

H	-7.059328000	-1.968297000	-3.163118000
Fe	-6.901085000	-0.132622000	-1.251972000
H	-1.412970000	-1.009627000	1.354016000

Ni-peptide Model

C	-2.205150000	-0.798767000	0.535569000
H	-1.885719000	-0.018633000	-0.182213000
C	-3.404835000	-0.344076000	1.358340000
O	-3.972469000	-1.069759000	2.176741000
N	-3.933983000	0.898183000	1.037477000
H	-3.338645000	1.591618000	0.579540000
C	-5.095836000	1.376147000	1.778481000
H	-4.826258000	1.616322000	2.829933000
C	-6.158250000	0.273211000	1.791281000
O	-6.351542000	-0.492588000	0.801105000
N	-7.059094000	0.223804000	2.780654000
H	-6.887233000	0.715964000	3.662074000
C	-8.278978000	-0.595668000	2.634107000
H	-8.010005000	-1.668949000	2.586087000
H	-8.874203000	-0.444876000	3.550792000
C	-9.135739000	-0.168575000	1.388107000
H	-8.858745000	0.853821000	1.081122000
H	-10.198287000	-0.155763000	1.695608000
C	-9.073498000	-1.063969000	0.159755000
O	-8.375355000	-0.912425000	-0.868277000
O	-9.933941000	-2.071058000	0.236111000
H	-9.898694000	-2.618783000	-0.584358000
C	-5.695282000	2.665509000	1.122794000
H	-6.298013000	3.186088000	1.889918000
H	-4.847995000	3.345431000	0.890840000
C	-6.554191000	2.446079000	-0.112441000
C	-6.029726000	1.849550000	-1.308874000
C	-7.899339000	2.851444000	-0.112305000
C	-6.860250000	1.703577000	-2.459708000
C	-8.723510000	2.681063000	-1.250770000
C	-8.213022000	2.098808000	-2.421428000
H	-4.944419000	1.701956000	-1.402943000
H	-8.315316000	3.338544000	0.781671000
H	-6.425712000	1.358905000	-3.406710000
H	-9.766297000	3.026503000	-1.219376000
H	-8.845090000	1.989549000	-3.312884000
C	-2.557560000	-2.128300000	-0.189571000
H	-1.691424000	-2.431010000	-0.814576000
H	-2.704389000	-2.915602000	0.571804000
C	-3.791411000	-2.043654000	-1.067336000
C	-3.881450000	-1.108931000	-2.131295000
C	-4.901288000	-2.902632000	-0.847118000
C	-5.003644000	-1.083129000	-3.001573000

C	-6.029779000	-2.877281000	-1.694883000
C	-6.087692000	-1.977338000	-2.795532000
H	-3.046092000	-0.421063000	-2.326512000
H	-4.875257000	-3.604215000	-0.001816000
H	-5.002150000	-0.407856000	-3.868608000
H	-6.862303000	-3.570535000	-1.513803000
H	-6.933153000	-2.005360000	-3.497272000
Ni	-6.404618000	-0.406713000	-1.118615000
H	-1.355314000	-0.987905000	1.220552000

Co-peptide Model

C	-2.194782000	-0.806989000	0.536442000
H	-1.858084000	-0.024118000	-0.170462000
C	-3.428728000	-0.359145000	1.308532000
O	-4.050079000	-1.100821000	2.074740000
N	-3.926058000	0.901187000	1.010409000
H	-3.306278000	1.601093000	0.596832000
C	-5.103881000	1.363393000	1.736015000
H	-4.853667000	1.578753000	2.797758000
C	-6.161278000	0.254898000	1.709528000
O	-6.390059000	-0.444431000	0.674094000
N	-7.034920000	0.157625000	2.719726000
H	-6.837130000	0.622892000	3.610076000
C	-8.242532000	-0.680945000	2.601717000
H	-7.951804000	-1.742171000	2.475748000
H	-8.781680000	-0.597938000	3.560631000
C	-9.188473000	-0.211967000	1.436123000
H	-8.951536000	0.829789000	1.160393000
H	-10.229544000	-0.237296000	1.810162000
C	-9.176280000	-1.057555000	0.173985000
O	-8.562733000	-0.815653000	-0.890962000
O	-9.957727000	-2.122720000	0.272944000
H	-9.953913000	-2.636347000	-0.570290000
C	-5.694937000	2.673637000	1.110274000
H	-6.316955000	3.163394000	1.882499000
H	-4.845265000	3.362899000	0.921323000
C	-6.521651000	2.497658000	-0.153679000
C	-5.949183000	1.993033000	-1.361890000
C	-7.890823000	2.846485000	-0.161320000
C	-6.753949000	1.835802000	-2.528665000
C	-8.688309000	2.686307000	-1.315132000
C	-8.130674000	2.167382000	-2.496376000
H	-4.864719000	1.829705000	-1.425672000
H	-8.339684000	3.273867000	0.747238000
H	-6.285978000	1.551736000	-3.481213000
H	-9.746783000	2.979496000	-1.290257000
H	-8.743616000	2.054301000	-3.401007000
C	-2.504299000	-2.142323000	-0.201084000

H	-1.640277000	-2.395808000	-0.849158000
H	-2.602967000	-2.948451000	0.548019000
C	-3.767902000	-2.075419000	-1.037947000
C	-3.898280000	-1.137241000	-2.090631000
C	-4.865382000	-2.933393000	-0.764822000
C	-5.066869000	-1.083939000	-2.887851000
C	-6.040310000	-2.882522000	-1.533219000
C	-6.159433000	-1.957650000	-2.609766000
H	-3.060135000	-0.468376000	-2.333437000
H	-4.787216000	-3.653282000	0.061397000
H	-5.095720000	-0.430243000	-3.770499000
H	-6.866212000	-3.574164000	-1.317306000
H	-7.024281000	-2.002870000	-3.288481000
Co	-6.640179000	-0.223703000	-1.230439000
H	-1.368990000	-0.981190000	1.254629000

Zn-peptide Model

C	-2.076759000	-0.706709000	0.544597000
H	-1.795008000	0.059382000	-0.203814000
C	-3.319947000	-0.286182000	1.322326000
O	-3.912622000	-1.037409000	2.100474000
N	-3.850578000	0.959163000	1.019535000
H	-3.267483000	1.670350000	0.574741000
C	-5.071759000	1.374087000	1.698330000
H	-4.881641000	1.559558000	2.777916000
C	-6.096342000	0.234966000	1.572447000
O	-6.142495000	-0.479722000	0.530262000
N	-7.050983000	0.105706000	2.503797000
H	-6.952106000	0.610026000	3.389759000
C	-8.139260000	-0.879687000	2.371484000
H	-7.732784000	-1.775008000	1.867971000
H	-8.427867000	-1.176699000	3.394612000
C	-9.413158000	-0.352250000	1.650910000
H	-9.476657000	0.753580000	1.746922000
H	-10.313081000	-0.737784000	2.165537000
C	-9.622948000	-0.658101000	0.172525000
O	-8.768125000	-0.768174000	-0.733380000
O	-10.908586000	-0.785787000	-0.111759000
H	-11.037782000	-0.954305000	-1.076131000
C	-5.666150000	2.687351000	1.074259000
H	-6.266106000	3.192406000	1.853851000
H	-4.818729000	3.368979000	0.854067000
C	-6.531049000	2.482902000	-0.160634000
C	-5.999992000	1.942651000	-1.362269000
C	-7.910080000	2.789043000	-0.122534000
C	-6.849665000	1.674632000	-2.474379000
C	-8.752539000	2.553573000	-1.229737000
C	-8.233783000	1.984571000	-2.403996000

H	-4.924090000	1.735273000	-1.442653000
H	-8.333925000	3.237258000	0.788500000
H	-6.412877000	1.340437000	-3.426818000
H	-9.815455000	2.826571000	-1.173447000
H	-8.879436000	1.808974000	-3.275441000
C	-2.318858000	-2.090083000	-0.129848000
H	-1.436083000	-2.333402000	-0.755917000
H	-2.393644000	-2.861456000	0.657576000
C	-3.572370000	-2.112992000	-0.984076000
C	-3.690940000	-1.264676000	-2.115937000
C	-4.663048000	-2.952756000	-0.645327000
C	-4.862696000	-1.242627000	-2.884729000
C	-5.843017000	-2.953010000	-1.404234000
C	-5.981562000	-2.065067000	-2.519125000
H	-2.841258000	-0.634543000	-2.414543000
H	-4.575873000	-3.614733000	0.226523000
H	-4.916752000	-0.623478000	-3.791474000
H	-6.665075000	-3.637375000	-1.149051000
H	-6.819294000	-2.195162000	-3.225034000
Zn	-6.840657000	-0.471054000	-1.265400000
H	-1.229174000	-0.804542000	1.252439000

5.0 UV-Vis Studies – UV-Vis absorption spectra were recorded on Thermo Scientific, Multiskan Go UV-Vis Spectrophotometer 10 mm quartz cell at at 25±0.1 °C.50μM solution of sPA1 in ethanol was titrated with aquous soltion of transition metal ions up to 1:1 sPA1-metal ions concetrations.

6.0 Preparation of self-assembed structres of sPA – The white solid sPA (1mg) was dissolved into 1mL of AR grade ethanol and diluted the solution to reach the final concentration upto 500μM. The freshly prepared solution of compound (500μM) was stored and used whenevere is required. 2-5μL aliquites of freshly prepaired ethanolic soltion of sPA 1(500μM) was transfered over freshly cleaved muscovite mica surface and dried under 60w bulb at dust free space for 30 minute followed by high vacuum. The sample was imaged under atomic force microscopy.

7.0 Preparation of self-assembed structres of sPA –metal ions: The metal ions salt, 1mg each, was dissolved into into 1 mL of milli Q water in five separate cleaned glass vial (3 mL). An

appropriate amount of metal ion solution (1-5μL) was added to the above prepaerd sPA solution to makeup 1: 1 ratio sPA-metal concentration. The samples of these sPA-metal ions conjugates solution (1:1) were also prepared by using above mentioned procedure and analysed by AFM and SEM.

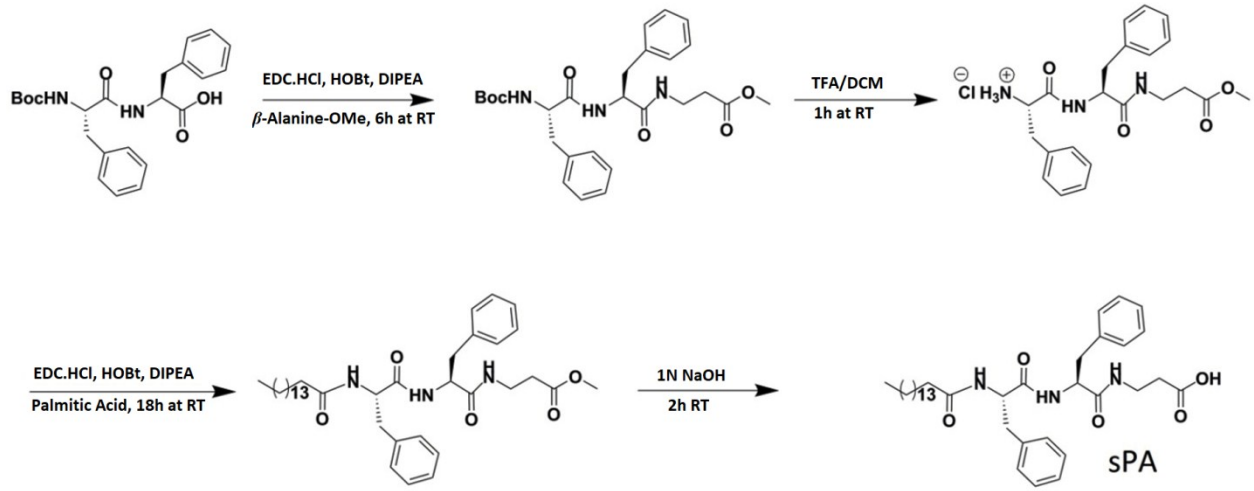
8.0 Atomic Force Microscopy (AFM) –All the samples were imaged under atomic force microscope, INNOVA, ICON analytical equipment, Bruker, placed at Sophisticated Instrument Center (SIC)-Dr. Harisingh Gour Central University, Sagar-M.P. india. 2-5μL aliquites of freshly prepaired ethanolic soltion of sPA1(500μM) was spread out over freshly cleaved muscovite mica surface and dried under 60w bulb at dust free space for 30 minute followed by high vacuum. Same procedure were followed for sPA-metal ions conjugates solution. AFM was operate under contact and tapping mode, with the aid of a cantilever (NSC 12(c) from MikroMasch, Silicon Nitride Tip by NanoDrive™ version 8 software. The resonant frequency of the used cantiliver was ~260 kHz. The images were taken in air at 25±0.1 °C with the scan speed of 1.5-2.0 lines/sec. The data analysis was done using of nanoscope analysis software.

9.0 Scanning Electron Microscopy (SEM): Freshly cleaved mica surfaces were used for all the samples. 10 μL aliqoutes of each samples were placed on it and the samples were dried under high vacuo and were directly mounted on the stage under native conditions and an image was taken for each sample with the help of high resolution scanning electron microscope dual beam system (NOVA 600 NANOLAB, D97 FEI) operating at WD 10.6 mm and 20 kV.

10.0 Peptide Synthesis - All peptide cojugates were synthesized by established solution phase synthesis lab protocol which was the analogous to previously synthesized short peptide

amphiphiles; Palmitic-Phe-Tyr-*β*-Ala-OH, Palmitic-Tyr-Phe-*β*-Ala-OH and Palmitic-Tyr-Tyr-*β*-Ala-OH,etc.[16-21] The synthesis was done by using simple solution phase fragment condensation methodologies using *t*-Boc chemistry and in the presence of HOBt. Compounds were charecterised by ^{1}H and ^{13}C NMR wherever necessary.The purity and identity of all the peptide conjugates were confirmed by HRMS.

Peptide Synthesis



Scheme-1: Synthetic scheme of short peptide amphiphile Palmitoyl- Phe-Phe-*β*-Ala, sPA

Peptide Synthesis:

Synthesis of *N-tert*-butyloxycarbonyl-L-Phenyl alanine, *N-tert*-butyloxycarbonyl- L-Phenyl alanine-L-Phenylalanine methyl ester, *N-tert*-butyloxycarbonyl-L-Phe-L-Phe:All amino acid

protection and synthesis of thesepeptideswere done via standard lab protocols and similar to previous reported workfollowed by simple purification and characterization and used them for nextsynthesis steps wherever needed(scheme S1).

Synthesis of Boc-Phe-Phe-β-Alanine-OMe: A Solution of compound Boc-Phe-Phe-OH (1.0 g, 2.424 mmol) in dry DCM (40 mL) was cooled to 0^{o}C and *N*-hydroxybenzotriazole (393 mg,2.90 mmol) was added, followed by *N*-(3-dimethylaminopropyl)-*N*′-ethylcarbodiimidehydrochloridewas added(558mg,2.90 mmol). After 1h the reaction mixture was allowed to warm to room temperature. The compound β-alanine methyl ester hydrochloride(372.0 mg,2.66 mmol)was dissolved in mixture of DMF (2.0mL) and DCM (15.0 mL) was added and followed by *N, N*-disopropylethylamine (~1.3 ml, 7.3 mmol).The reaction mixture was further stirred for 12 hours. Reaction was monitored by TLC.After 12 hours, the reaction mixture was acidified with 1N HCl to pH 2-3 under ice cold condition and extracted with DCM.The organic layer was washed with $NaHCO_3$ solution and finally with brine solutionfollowed by drying of organic layer over anhydrous sodium sulphate. Dichloromethane was evaporated to get the crude compound which was further purified with silica gel column chromatography(2% methanolgradient in dichloromethane) to get protected compound N-*tert*-butoxyl-L-Phenyl alanine-L-Phenyl alanine -β-alanine ester as a white solid(805 mg,66.7 % yield),R_f value is 0.45 (5 % methanol in dichloromethane). Product was used directly for next step.

Synthesis of NH_2-Phe-Phe-β-Ala-OMe: Synthesis of (L-Phe-L-Phe-β-Ala-OMe)- Compound Boc-Phe-Phe-β-Ala-OMe(900 mg, 1.80mmol) was dissolved in a mixture of DCM (10.0 mL) and trifloroacetic acid (3.0 mL) and stirred for 3h. Reaction was monitored by TLC over 4 hours.ThenDCM and TFA was evaporated under nitrogen stream.The crudemixture was dissolved in methanol and passed through the activated anion exchange dowex resin followed by evaporation of solvent to get the pure product as an off white gummy productand used for next steps without further purification. $R_f$value is 0.5(10 % methanol in dichloromethane) (Yield: 580 mg, 81%).

Synthesis of Palmitoyl-Phe-Phe-β-Ala-OMe:A Solution of Palmitic acid (407.0 mg, 1.02 mmol, 1 eq.), 1-ethyl-3-(3-dimethylaminopropyl) carbodiimidehydrochloride (EDC.HCl215.0

mg, 1.12 mmol, 1.1 eq.), and *N*-hydroxybenzotriazole (165.0 mg, 1.22 mmol, 1.2 eq.) were dissolved in dry DCM (50.0 mL) in a two-neck round-bottom flask under N_2 atmosphere and compound L-Phe-L-Phe-β-Ala-OMe (405.0 mg, 1.02 mmol, 1.0 eq) was dissolved in DCM (10.0 mL) was added and followed by *N, N*-diisopropylethylamine (~0.55 ml, 3.06 mmol). The reaction mixture was stirred for 12h. Solvent was evaporated under high vacuum. The crude compound was acidified with 1N HCl to pH 2-3 under ice cold condition and extracted with DCM. The organic layer was dried over anhydrous sodium sulphate. Dichloromethane was evaporated to get the crude compound which was further purified with silica gel column chromatography (0.5-2.0% methanol gradient in dichloromethane) to give protected compound Palmitoyl-L-Phenylalanine-L- Phenylalanine -*β*-alanine methyl ester as white solid R_f value is 0.5 (5 % methanol in dichloromethane), (Yield 502 mg, 77.5%).

^{1}HNMR (500 MHz, DMSO-*d*$_6$, 25 °C) δ (ppm) = 0.790-0.824 (t, *J* = 10.3 Hz, 3H), 0.999-1.295 (m, 24H), 1.913-1.950(t, *J* = 11.45Hz, 2H), 2.323-2.417 (m, 4H), 2.565-2.795(m, 2H), 2.864-2.925(m, 2H), 3.162-3.272 (m, 2H), 3.552(s, 3H), 4.362-4.466(m, 2H), 7.034-7.218(m, 10H), 7.852-7.973 (m, 1H), 8.062-8.090 (t, *J* = 8.08 Hz, 1H), 8.319-8.340(d, *J* = 8.33 Hz, 1H).

^{13}CNMR (125 MHz, DMSO-*d*$_6$, 25 °C) δ(ppm)= 14.58, 22.84, 25.72, 29.50, 31.78, 33.97, 34.98, 35.62, 37.69, 38.28, 51.85, 54.25, 54.30, 126.70, 128.36, 128.3654, 129.7002, 138.0811, 138.5769, 171.2805, 171.7000, 172.6917.

Synthesis of Palmitoyl-Phe-Phe-βAla: Palmitoyl-Phe-Phe-β-Ala-OMe (500mg,0.786 mmol)was dissolved in minium volume of methanol (20.0 mL) and NaOH solution (1N, 0.84 mmol, 1 mL) was added and stirred for 3h. Then reaction mixture was passed through the activated strong cation exchange Amberlite IR 120. Solution was evaporated and further dried in high vaccum to get the Palmitoyl-Phe-Phe-β-Ala as a white solid (450.0 mg, 92 % Yield), R_f value is 0.45 (10% methanol in dichloromethane).

^{1}HNMR (500 MHz, DMSO-*d*$_6$, 25 °C) δ (ppm) = 0.790-0.807(t,*J*=8.6 Hz,3H),1.002-1.279(m,24H),1.914-1.950(t,*J* = 9.15 Hz, 2H),2.244-2.331(m,4H), 2.579-2.795(m,2H),2.873-2.955(m, 2H), 3.126-3.254 (m, 2H), 4.371-4.470(m,2H), 7.032-7.226(m, 10H), 7.847-7.975 (m, 1H), 8.043-8.070 (t, *J* = 8.06 Hz, 1H), 8.294-8.316(d, *J* = 8.31 Hz,1H).

^{13}CNMR (125 MHz, dmso-d_6, 25 °C) δ(ppm)= 14.5225, 22.6364, 25.6398, 28.9006, 29.6253, 31.8468, 34.3258, 35.3079, 35.7751, 54.0815, 54.3866, 126.5824, 126.7922, 128.3749, 128.5561, 129.6335, 129.7384, 138.1097, 138.5674, 171.1280, 172.5963, 173.4544.

HRMS, Calculated for $C_{37}H_{56}N_3O_7$ $[M+H]^+$ = 622.4214 and found 622.4225.

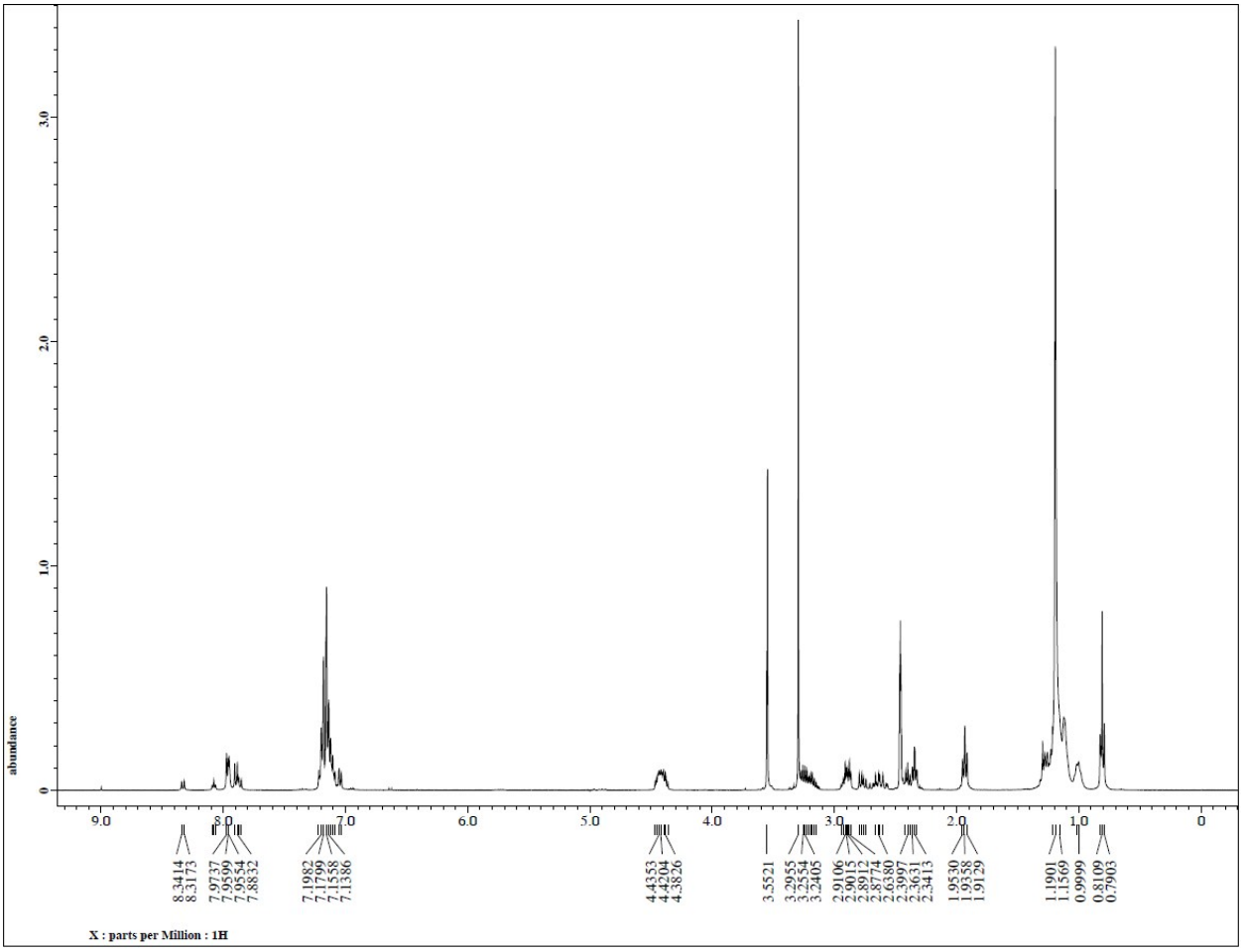


Figure S1: ^{1}H NMR of HPLC purified Pal-FF-β-Ala-OMe in DMSO-d_6

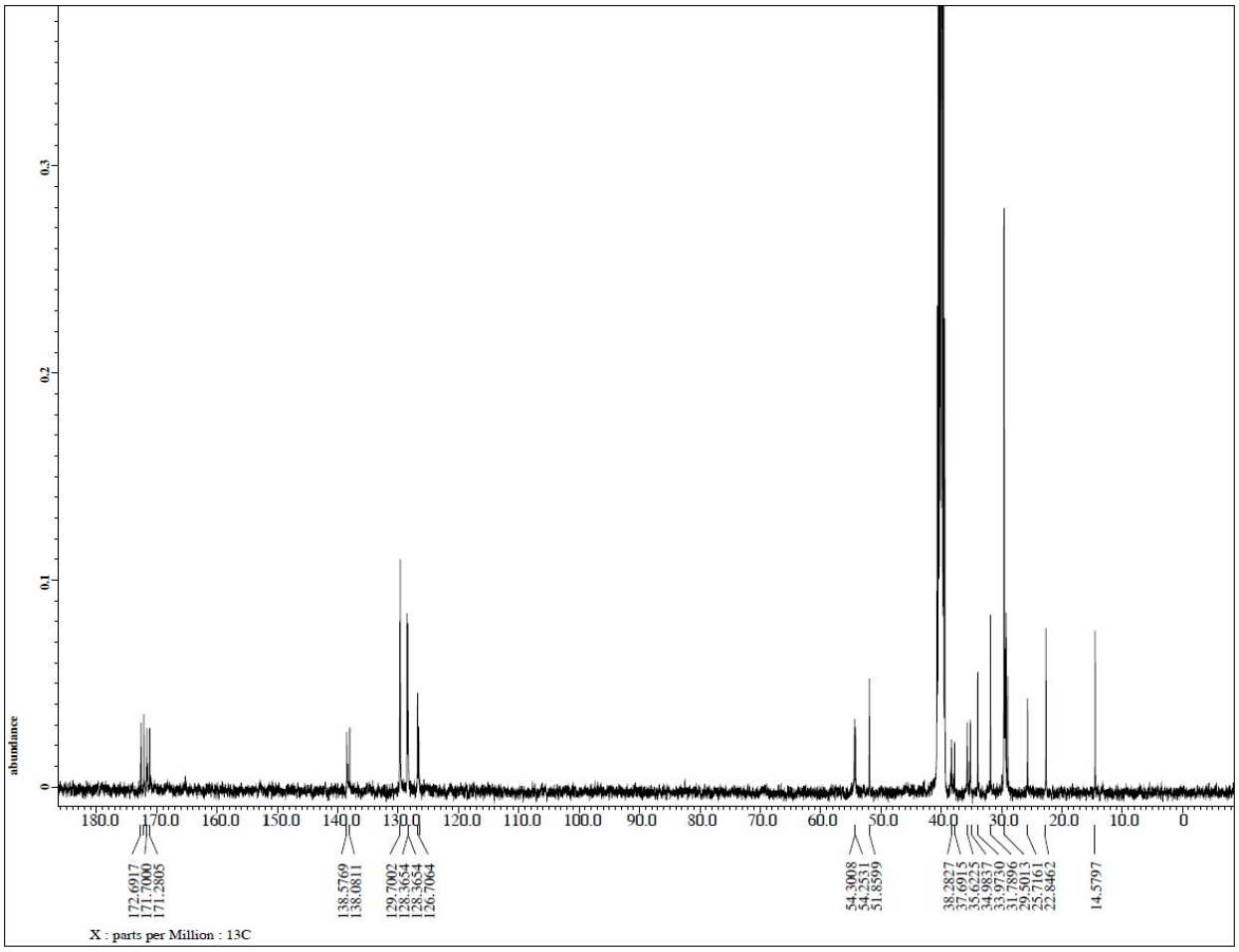


Figure S2: ^{13}C NMR of HPLC purified Pal-FF-β-Ala-OMe in DMSO-d_6

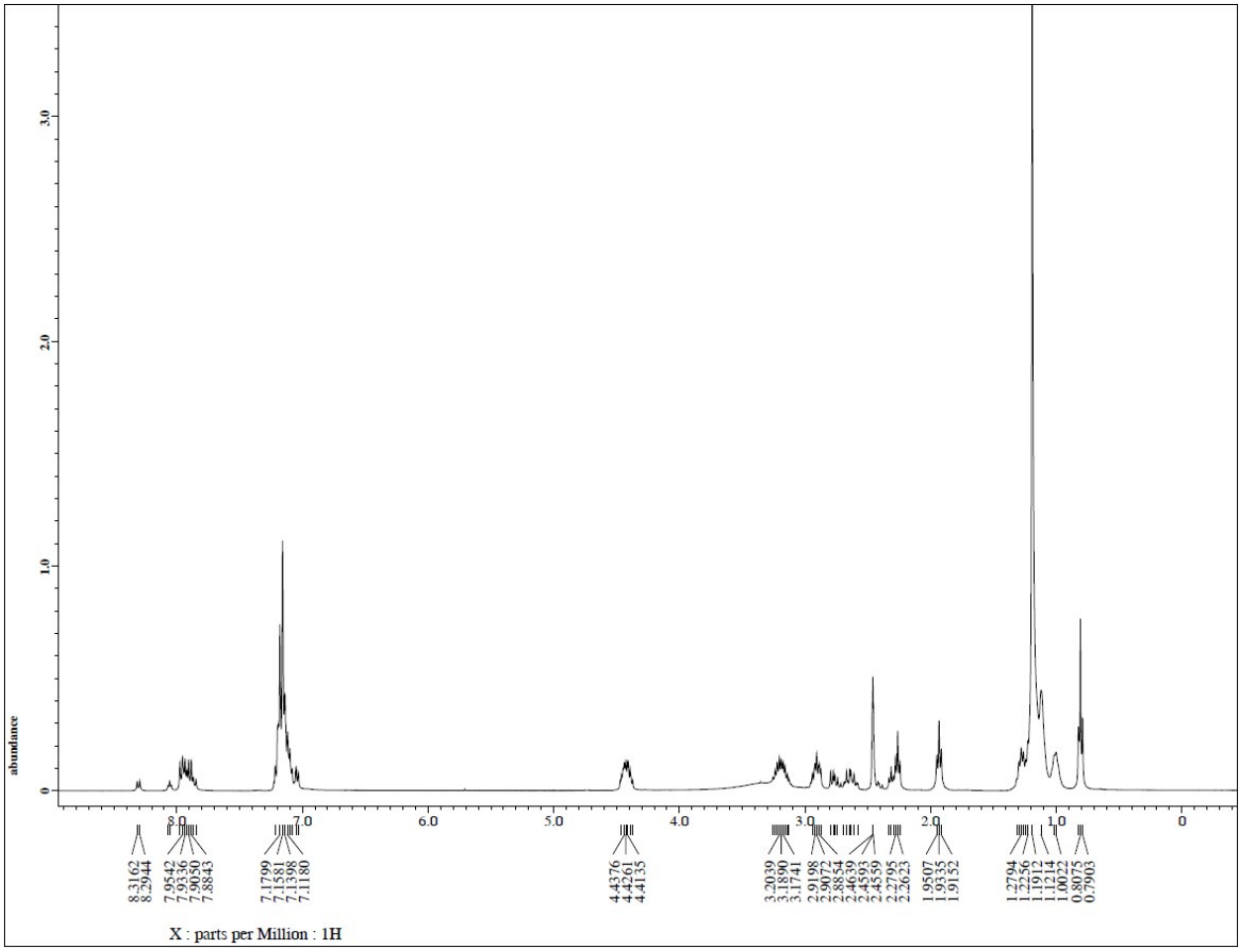


Figure S3: ^{1}H NMR of HPLC purified Pal-FF-β-Ala-OH in DMSO-d_6

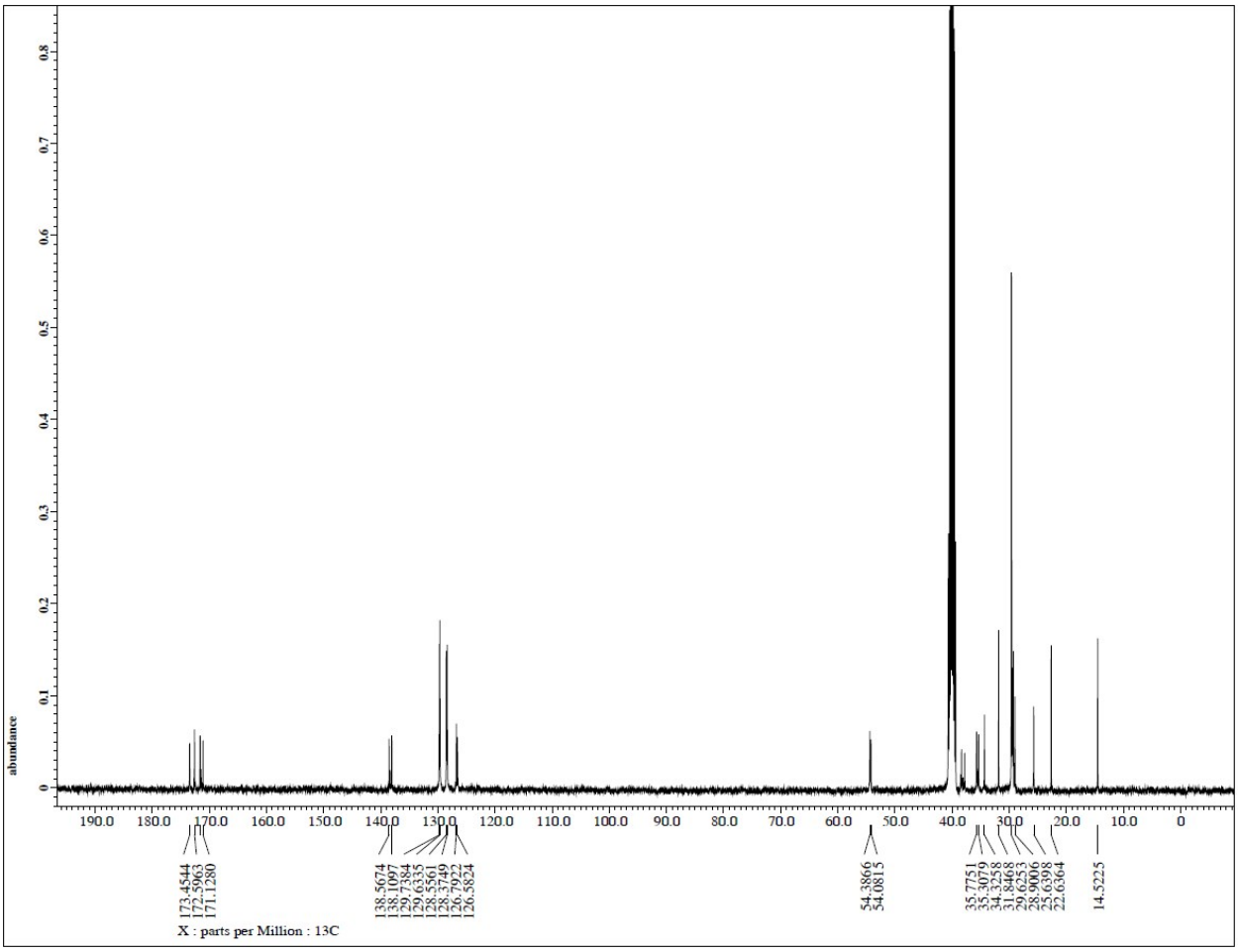


Figure S4: ^{13}C NMR of HPLC purified Pal-FF-β-Ala-OH in DMSO-d_6

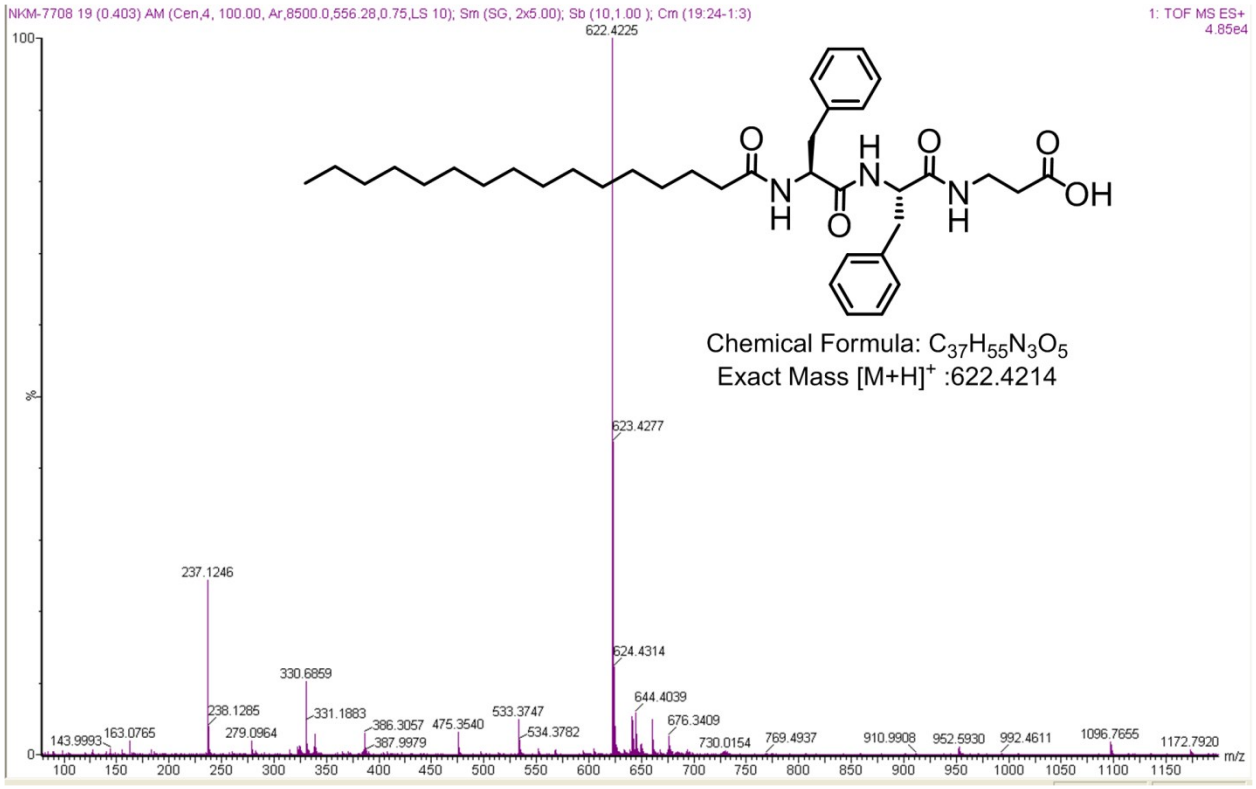


Figure S5: HRMS-ESI of HPLC purified Pal-FF-β-Ala-OH(sPA1).

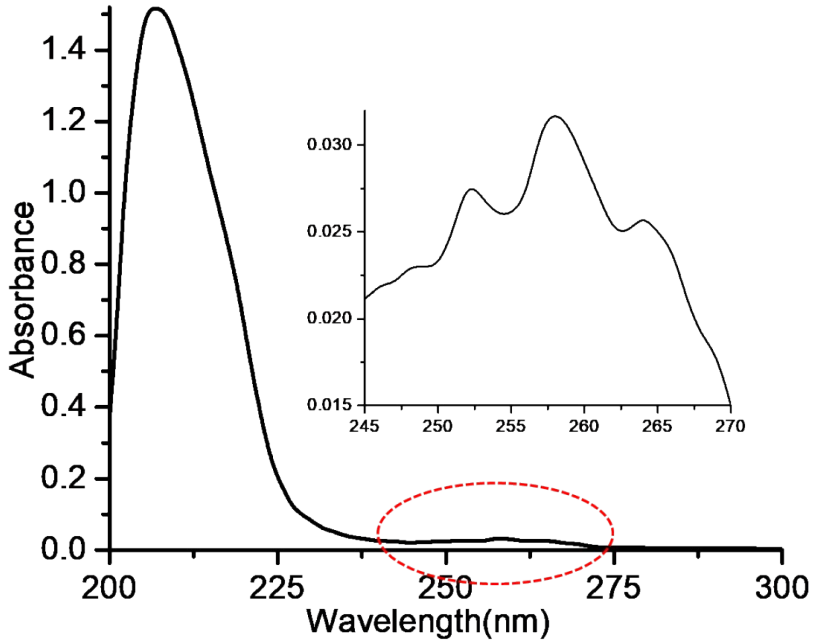


Figure S6: UV/Vis spectra of sPA 1 in ethanol (50μM).

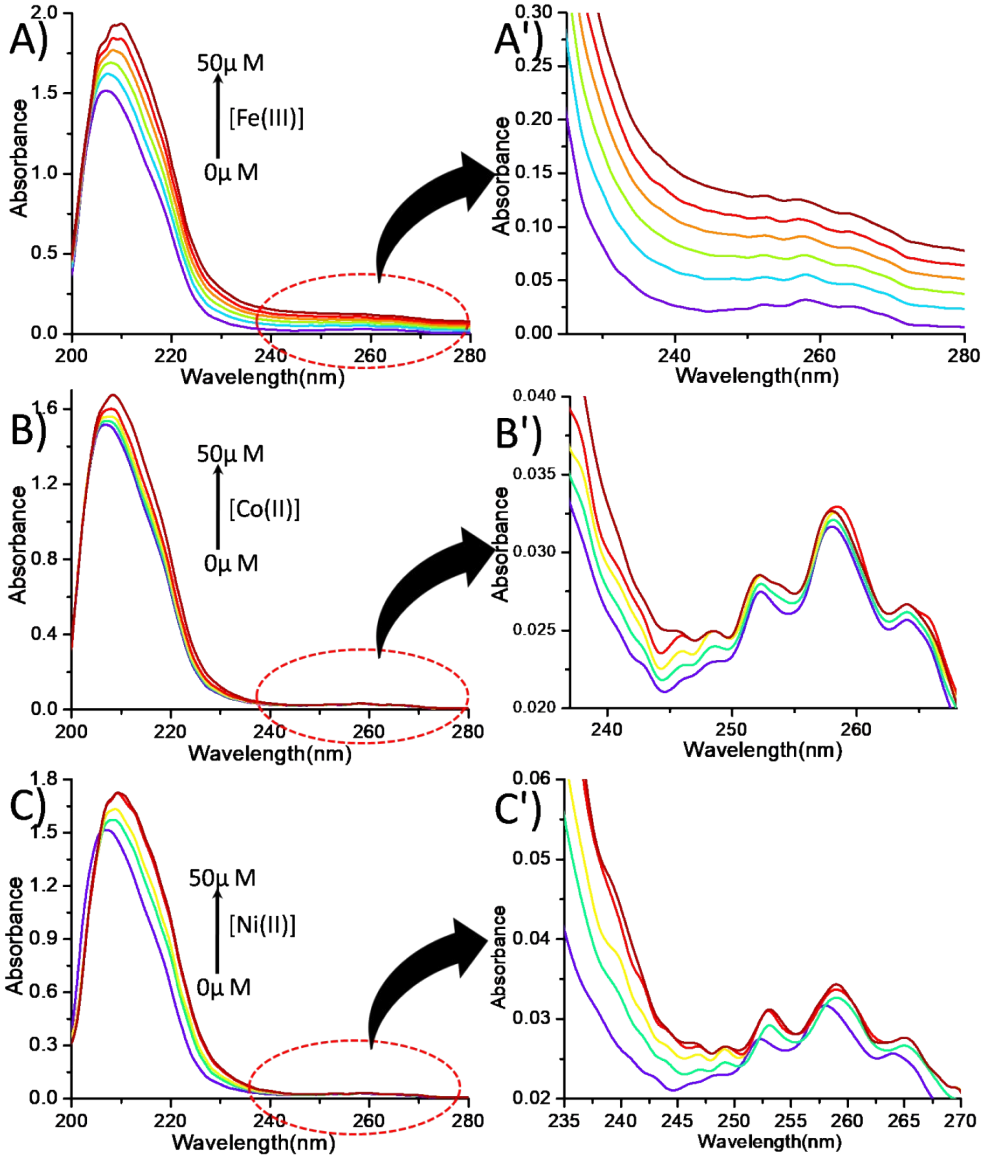


Figure S7: UV/Vis titration spectra of sPA(50µM) with different metal ions; A&A') versus Fe(III) ions B&B') versus Co(II) ions and C&C') versus Ni(II) ions.

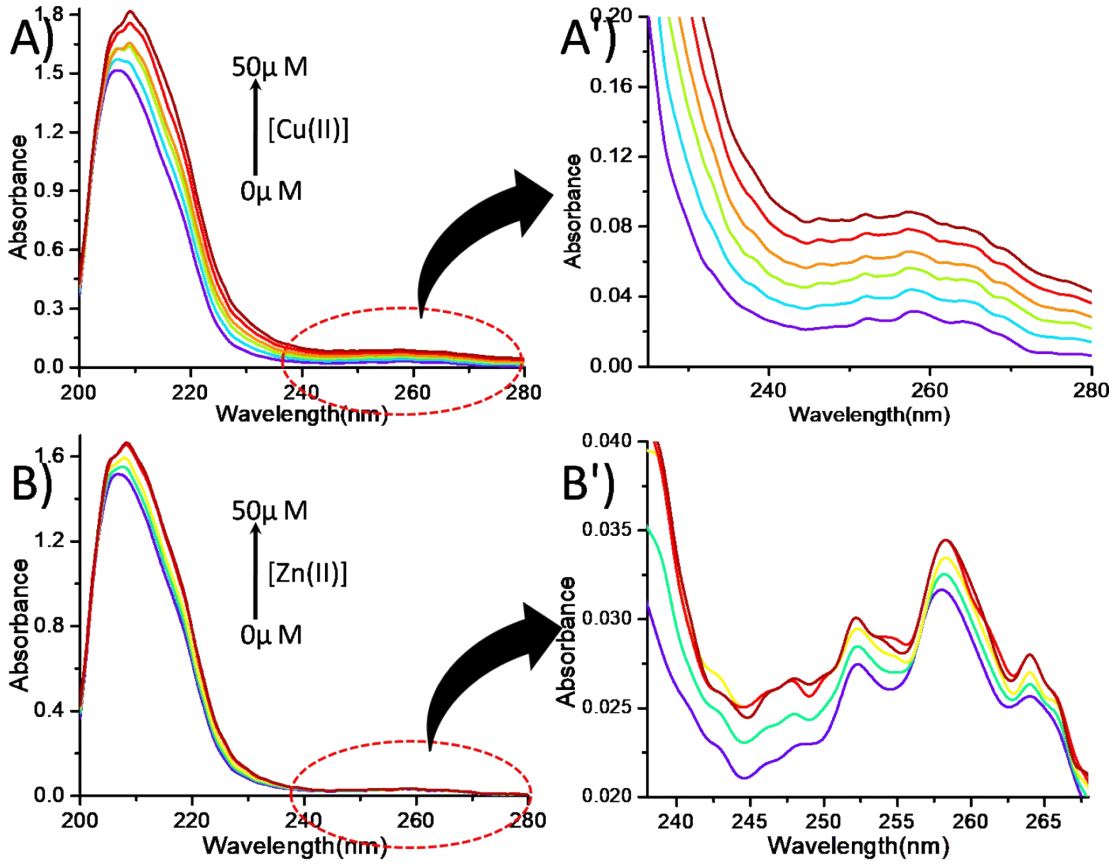


Figure S8: UV/Vis titration spectra of sPA(50µM) with different metal ions; A&A') versus Cu(II) ions and B&B') versus Zn(II) ions.

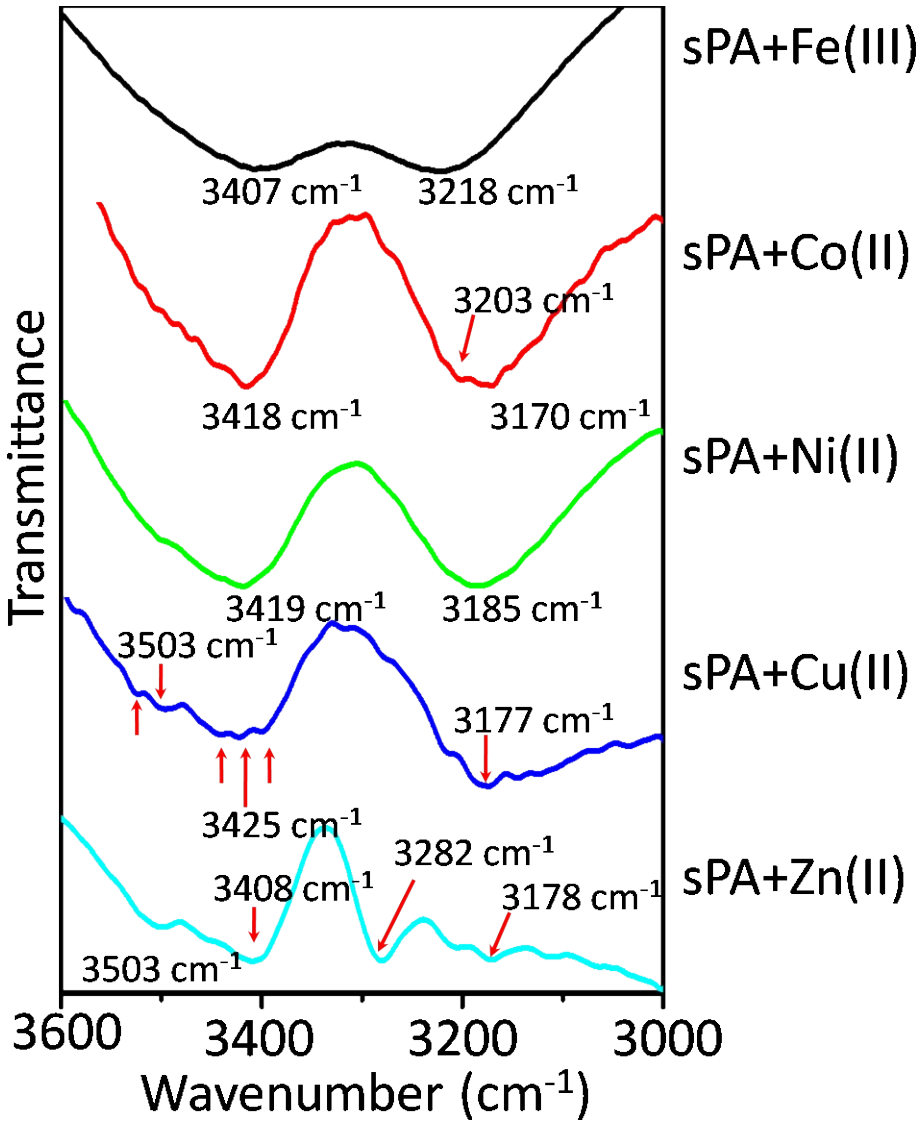


Figure S9: The FT-IR spectra of metal-sPA conjugates in amide bond A&B region, ranging from 3600-3000 cm^{-1} representing hydrogen bonded and free N-H bond streching of peptide bond.

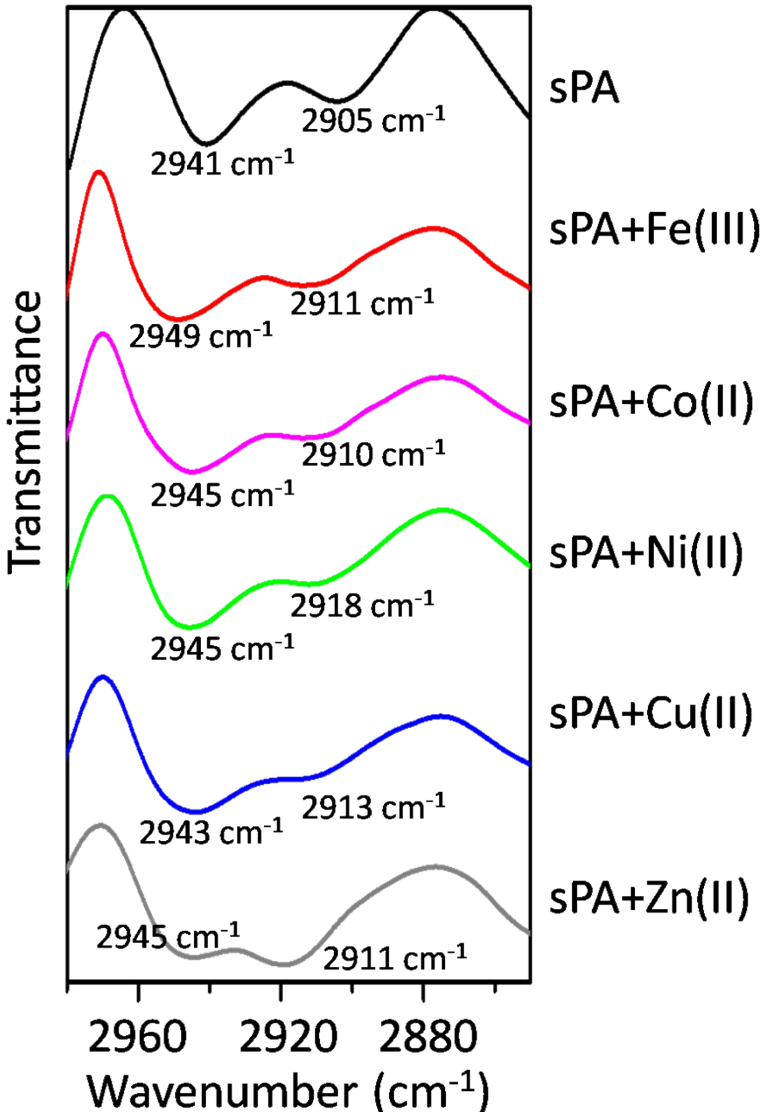


Figure S10: The FT-IR spectra of metal-sPA conjugates, ranging from 2850-2950 cm^{-1} representing C-H bond streching of aliphatic lipid chain.

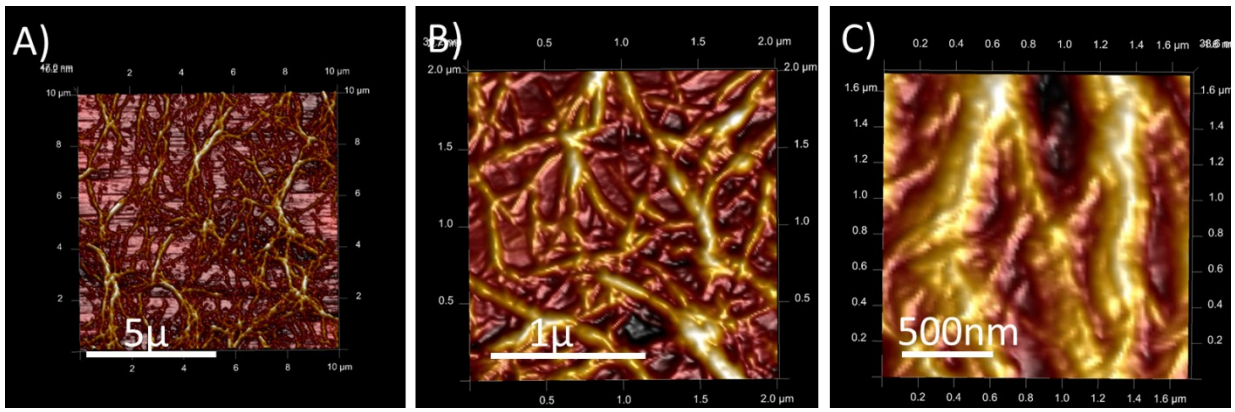


Figure S11: Picture depicts; A) 3D AFM image of nature of self-assembly of sPA (500 µM in ethanol) and B & C) its magnified high resolution image.

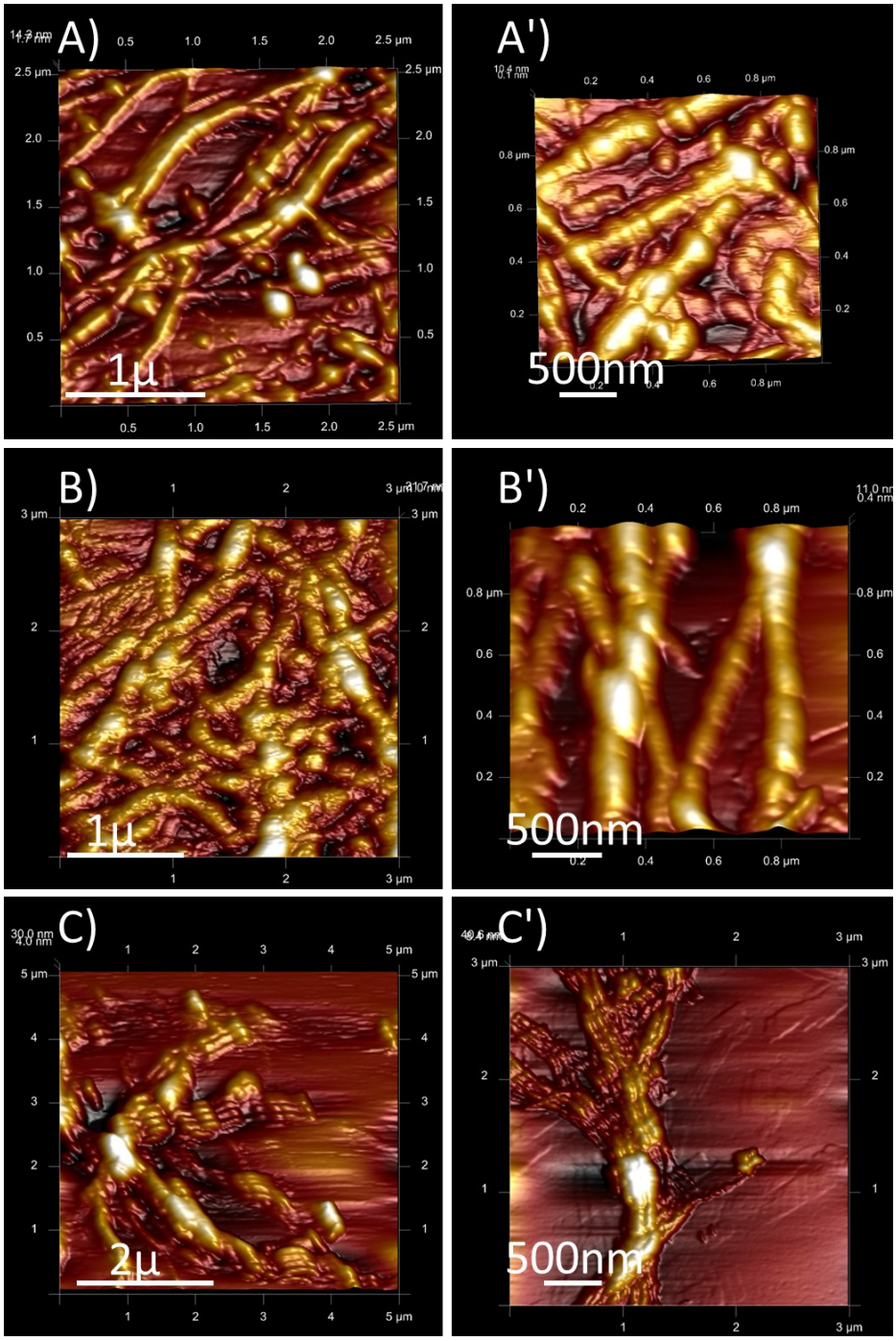


Figure S12: AFM images representing 3D AFM micrographs of self-assembly of sPA (500 µM) with different metal ions (1:1). A&A') in the presence of Fe(III) ions and its magnified high resolution image respectevely, B&B') in the presence of Co(II) ions and its magnified high resolution image respectevely, C&C') in the presence of Ni(II) ions and its magnified high resolution image respectively.

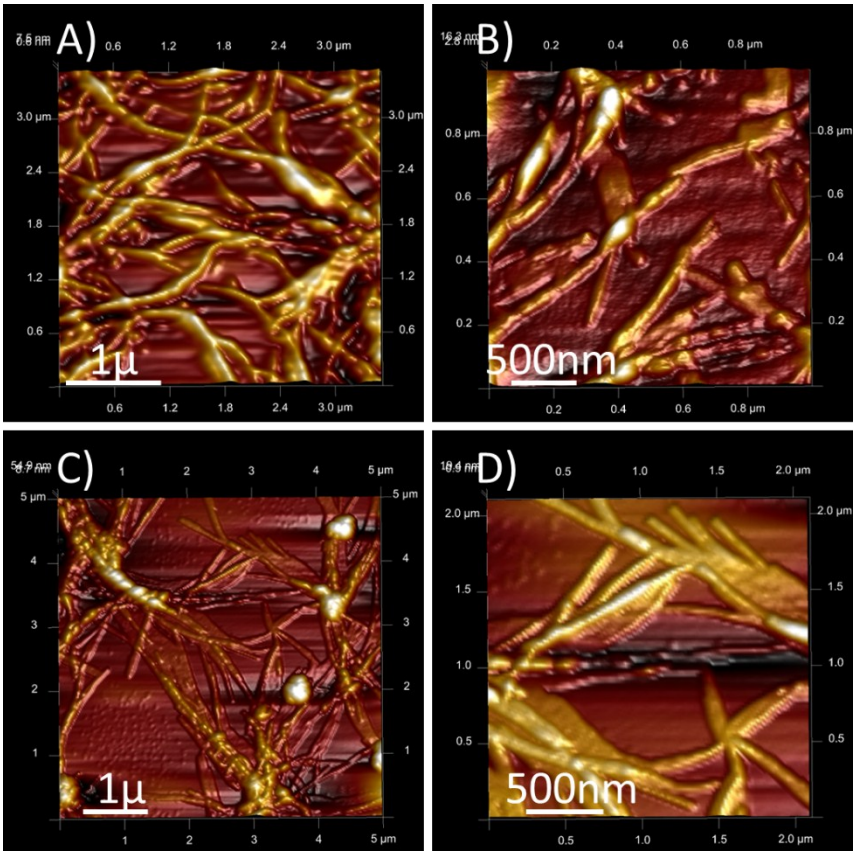


Figure S13: AFM images representing 3D AFM micrographs of self-assembly of sPA (500 µM) with different metal ions (500 µM). A) in the presence of Cu(II) ions, B) its magnified high resolution image, and C) in the presence of Zn(II) ions, D) its magnified high resolution image.

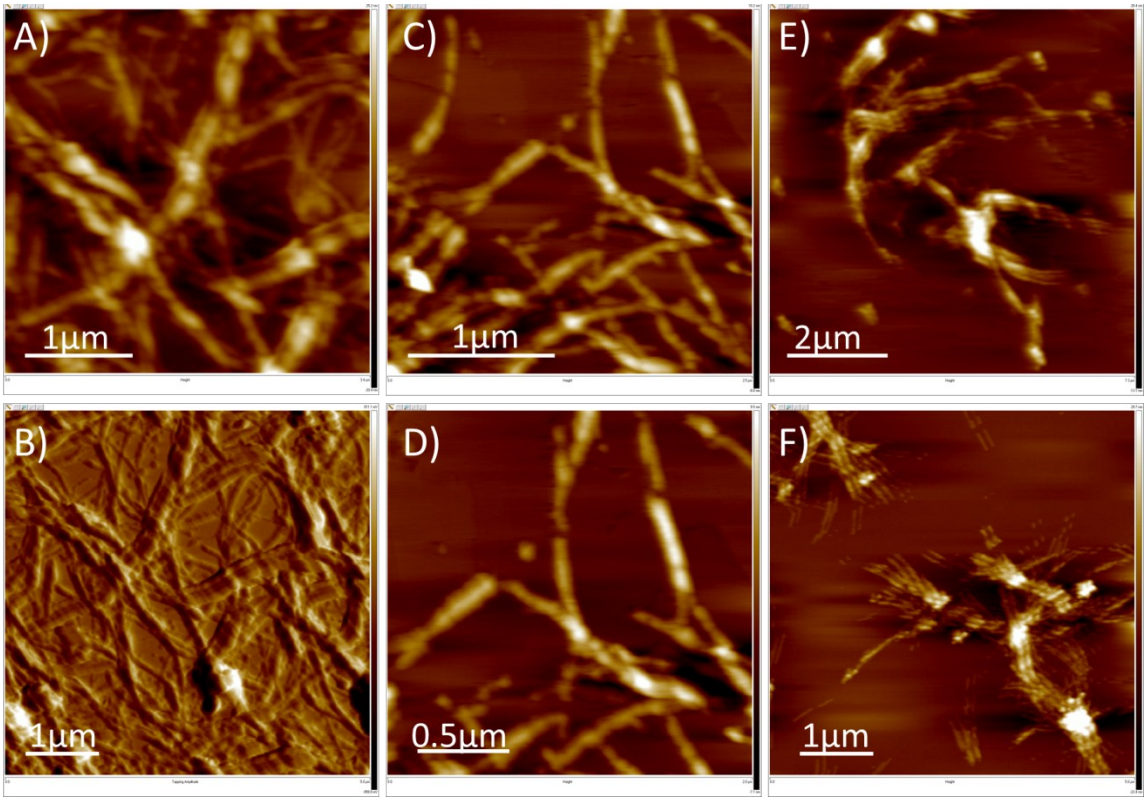


Figure S14. Depicts AFM image of sPA1-metal ions (1:1) A&B) sPA1-Fe^{3+}ions, C&D) sPA-Co^{2+} ions and E&F) sPA-Ni2+ ions.

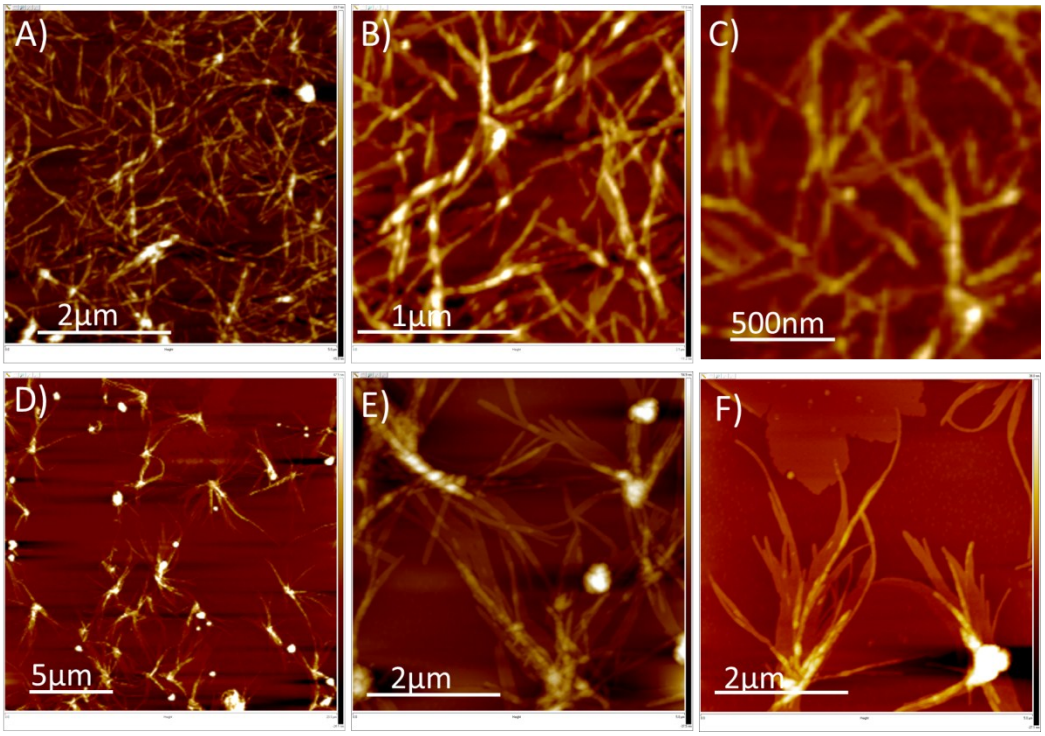


Figure S14. Depicts AFM image of sPA1-metal ions (1:1);*Top penal:*sPA1-Cu^{2+} ions conjugate and *Bottom penal:* sPA-Zn^{2+} ions conjugate.

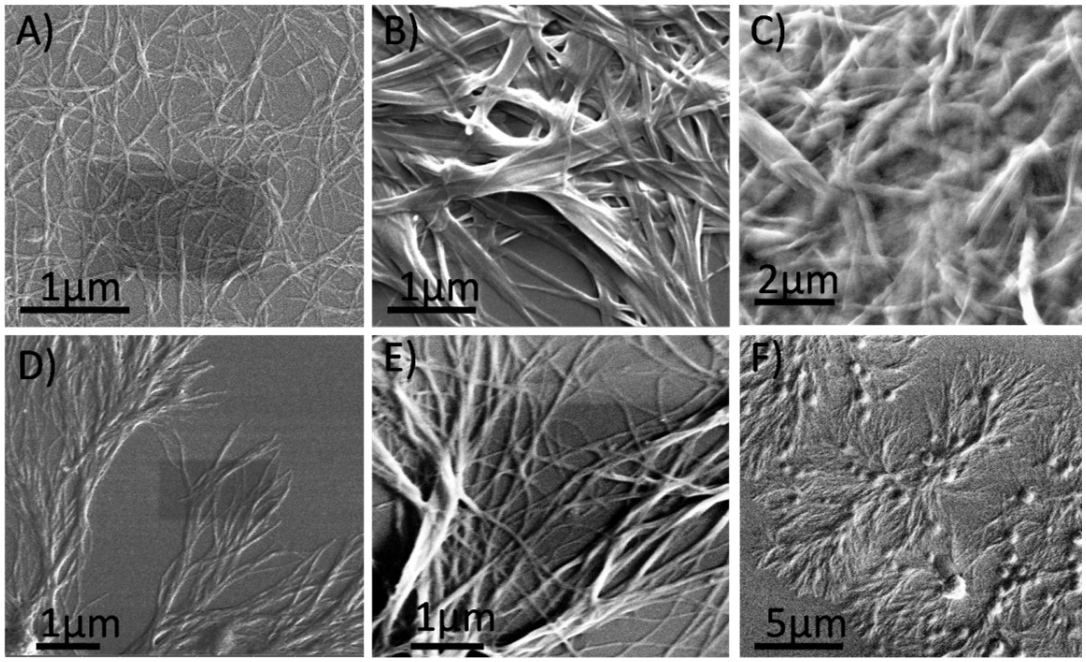


Figure S15: SEM images representing self-assembly of sPA (500 µM) without and different metal ions (500 µM). A) without metal ion, B) in the presence of Fe(III), C) in the presence of Co(II), D) in the presence of Ni(II), E) in the presence of Cu(II) ions, F) in the presence of Zn(II) ions.

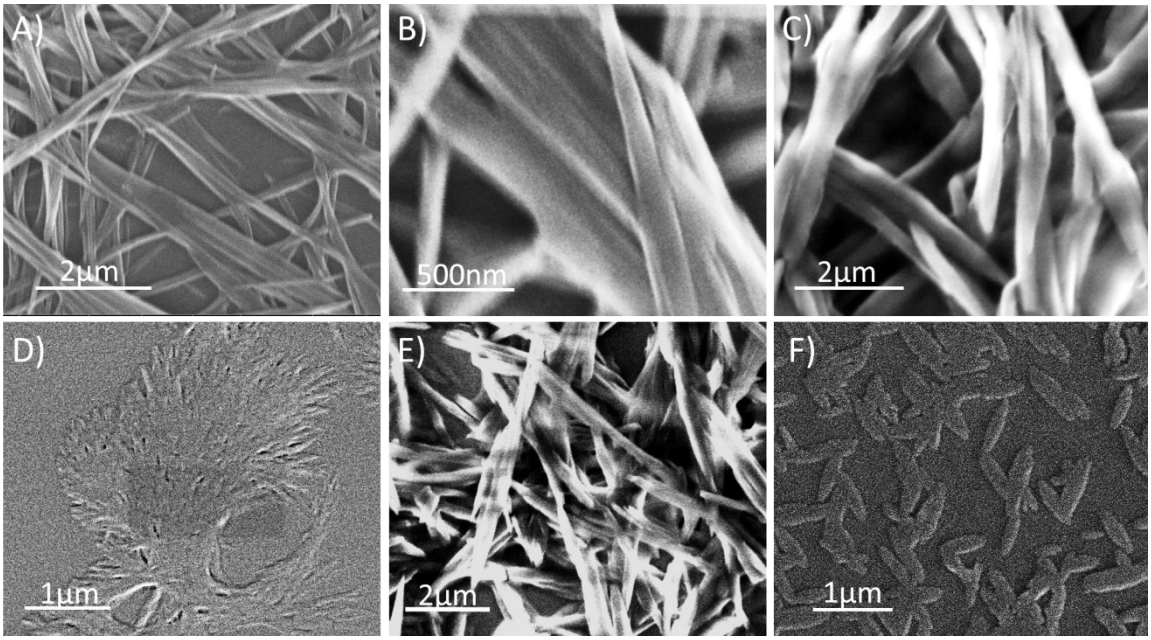


Figure S16: SEM images representing of self-assembly of sPA (500 µM) with different metal ions (1:3). A&B) in the presence of Fe(III) ionsand its magnified high resolution image

respectively, C) in the presence of Co(II) ions, D) in the presence of Ni(II), E) in the presence of Cu(II) and F) in the presence of Zn(II).

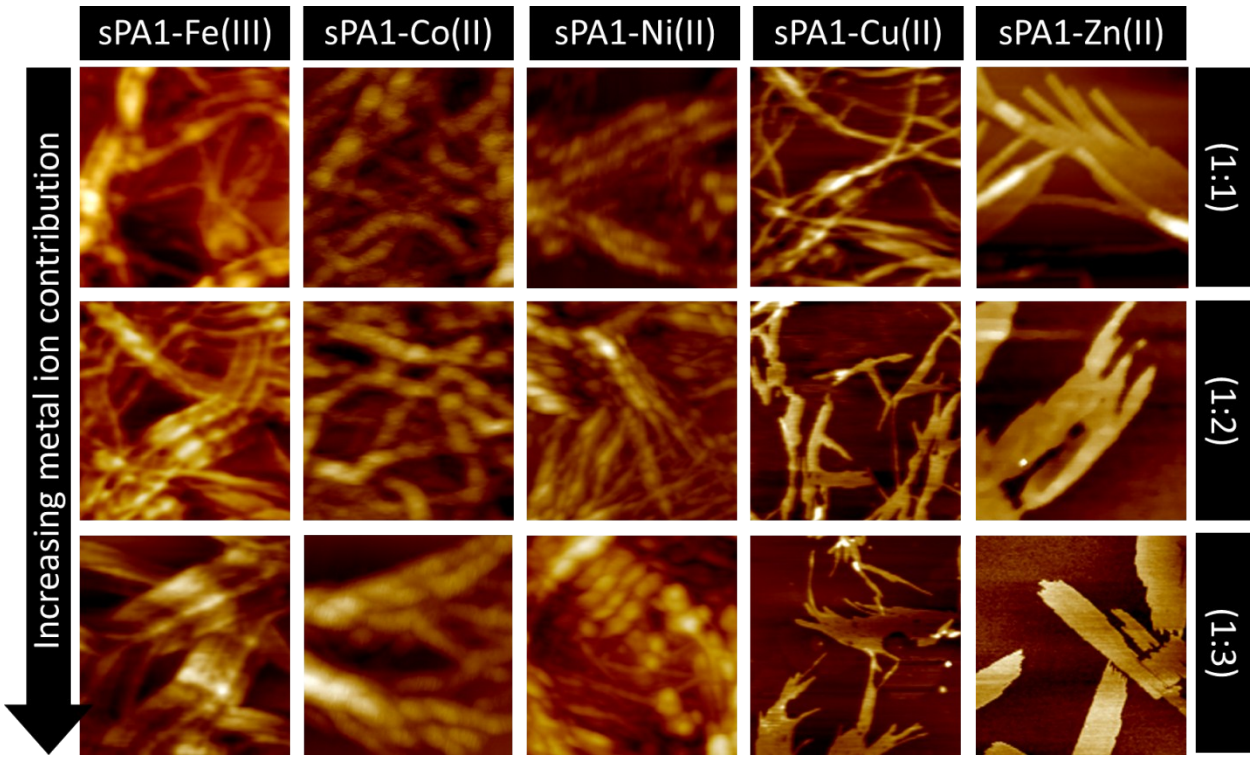


Figure S17: AFM images representing structural transition of self-assembly of sPA (500 μM) with different metal ions at different concentrations from (1:1) to (1:3); *Top panel*: represent morphology of sPA-metal ions in (1:1) combination, *Midle Panel*:represent morphology of sPA-metal ions in (1:2) combination and *Bottom panel*: represent morphology of sPA-metal ions in (1:3) combination.

	Structure	Wavenumber	Peak	Percent
PFF-β-Ala-OH	β-Sheet	1610-1640 cm^{-1}	1623 cm^{-1}	19.88%
	Random coil	1640-1650 cm^{-1}	1649 cm^{-1}	38.01%
	α-Helix	1650-1660 cm^{-1}	-	0%
	Antiparallel β-Sheet	1660-1695 cm^{-1}	1664 & 1682 cm^{-1}	42.10%

Table S1. The percentase contribution of β-sheet, α-helix, antiparallel β-sheet and random coil pattern of secondary structure of sPA.

	Structure	Wavenumber	Peak	Percent
PFF-β-Ala-OH + Fe(III)	β-Sheet	1610-1640 cm^{-1}	1625, 1638 cm^{-1}	38.73%
	Random coil	1640-1650 cm^{-1}	-	0 %
	α-Helix	1650-1660 cm^{-1}	1651 cm^{-1}	30.21%
	Antiparallel β-	1660-1695 cm^{-1}	1669, 1680 & 1691	31.04%

	Sheet		cm^{-1}	

Table S2. The percentase contribution of β-sheet, α-helix, antiparallel β-sheet and random coil pattern of secondary structure of sPA-Fe(III).

	Structure	Wavenumber	Peak	Percent
PFF β-Ala-OH + Co(II)	β-Sheet	1610-1640 cm^{-1}	1621 & 1637 cm^{-1}	29.27%
	Random coil	1640-1650 cm^{-1}	1649 cm^{-1}	18.07 %
	α-Helix	1650-1660 cm^{-1}	1659 cm^{-1}	11.27%
	Antiparallel β-Sheet	1660-1695 cm^{-1}	1668, 1671 & 1683 cm^{-1}	41.36%

Table S3. The percentase contribution of β-sheet, α-helix, antiparallel β-sheet and random coil pattern of secondary structure of sPA-Co(II).

	Structure	Wavenumber	Peak	Percent
PFF β-Ala-OH + Ni(II)	β-Sheet	1610-1640 cm^{-1}	1622 & 1638 cm^{-1}	28.96%
	Random coil	1640-1650 cm^{-1}	1644 cm^{-1}	0.71 %
	α-Helix	1650-1660 cm^{-1}	1654 cm^{-1}	15.45%
	Antiparallel β-Sheet	1660-1695 cm^{-1}	1667, 1671 cm^{-1}	54.87%

Table S4. The percentase contribution of β-sheet, α-helix, antiparallel β-sheet and random coil pattern of secondary structure of sPA-Ni(II).

	Structure	Wavenumber	Peak	Percent
PFF β-Ala-OH + Cu(II)	β-Sheet	1610-1640 cm^{-1}	-	0%
	Random coil	1640-1650 cm^{-1}	1643 cm^{-1}	50.62%
	α-Helix	1650-1660 cm^{-1}	1658 cm^{-1}	11.35%
	Antiparallel β-Sheet	1660-1695 cm^{-1}	1680 cm^{-1}	38.01%

Table S5. The percentase contribution of β-sheet, α-helix, antiparallel β-sheet and random coil pattern of secondary structure of sPA-Cu(II).

	Structure	Wavenumber	Peak	Percent
PFF-β-Ala-OH + Zn(II)	β-Sheet	1610-1640 cm^{-1}	1636 cm^{-1}	56.82%
	Random coil	1640-1650 cm^{-1}	-	0 %
	α-Helix	1650-1660 cm^{-1}	-	0%
	Antiparallel β-Sheet	1660-1695 cm^{-1}	1661 cm^{-1}	43.17%

Table S6. The percentase contribution of β-sheet, α-helix, antiparallel β-sheet and random coil pattern of secondary structure of sPA-Zn(II).

References:

[1] Natalello, D. Ami, S. Brocca, M. Lotti and S. M. Doglia, *Biochem. J.*, 2005, **385**, 511–517.

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