Appendix B:

Experimental Methods and Supplementary Figures for Chapter 3: Magnetic Relaxation in CuPc

and VOPc

Methods

B.1 Synthesis and Sample Preparation

Copper phthalocyanine (CuPc), zinc phthalocyanine (ZnPc), titanyl phthalocyanine (TiOPc, Type IV), and vanadyl phthalocyanine (VOPc) were purchased from Sigma Aldrich and used without further purification.

CuPc:ZnPc 1:1000

CuPc:ZnPc 1:1000 was prepared by a modification of previously reported preparations¹ of α -CuPc. CuPc (0.5 mg) and ZnPc (498.7 mg) were added to a 50 mL Erlenmeyer flask with a magnetic stir bar. Concentrated H₂SO₄ (10 mL) was added, dissolving the materials, and the dark green solution was stirred for 15 min. The solution was then poured onto DI H₂O ice (previously prepared) to cause precipitation of a dark green solid. The precipitate was filtered, washed with DI H₂O, and dried overnight under vacuum on a Schlenk line.

CuPc:ZnPc 1:100

CuPc:ZnPc 1:100 was prepared analogously to the 1:1000 sample. CuPc (2.0 mg), ZnPc (196.5 mg), and H_2SO_4 (5 mL) were used for the appropriate ratios.

VOPc:TiOPc 1:1000

VOPc:TiOPc 1:1000 was prepared via an established method.² VOPc (Type II, 0.5 mg) and TiOPc (Type IV, 497.0 mg) were added to a 250 mL Erlenmeyer flask with a magnetic stir bar. A mixture of trifluoroacetic acid (11 mL) and dichloromethane (DCM) (44 mL) was then added to dissolve the reagents. The dark blue-green solution was stirred for 15 min and then poured into isopropyl alcohol (IPA) (460 mL) causing the precipitation of a fine bright blue precipitate. The mixture was stirred for an additional 15 min. Fractions were centrifuged and the blue residue was washed with IPA and recentrifuged. IPA was used to transfer the remaining blue residue to a 100 mL round-bottom flask, and the solvent was removed via rotary evaporation. The sample was then rigorously dried overnight under vacuum on a Schlenk line.

VOPc:TiOPc 1:100

VOPc:TiOPc 1:100 was prepared analogously to the 1:1000 sample as above. VOPc (Type II, 1.7 mg), TiOPc (Type IV, 172.9 mg), trifluoroacetic acid (4 mL), DCM (16 mL), and IPA (200 mL) were used for the appropriate ratios.

B.2 EPR Spectroscopy

Continuous wave (CW) X-Band EPR spectra were acquired on a Brucker EMX spectrometer. All pulse X- and Q-band EPR experiments were performed using a Bruker ELEXSYS E580 pulse EPR Spectrometer. X-band measurements were performed using a Bruker MS-5 Resonator. Simulations of all CW and pulse EPR data were achieved using the EasySpin simulation toolbox (release 5.2.25) with MATLAB 2019b.³ Q-band measurements were performed using a Bruker MD-4 X-band Resonator. Temperature control was achieved using an Oxford Instruments CF935 cryogen flow cryostat using liquid helium (5 -100 K) or liquid nitrogen (>100 K) and a Mercury ITC temperature controller. Pulse electron spin-echo detected EPR (ESE-EPR) field-swept spectra were acquired using the 2-pulse "Hahn-echo" sequence ($\pi/2 - \tau - \pi -$ echo). T_m measurements were performed using the same Hahn echo sequence ($\pi/2 - \tau - \pi -$ echo) at fixed magnetic fields, with τ varied at regular intervals to measure the decay in echo intensity. T₁ measurements were performed using the inversion recovery pulse sequence ($\pi - T - \pi/2 - \tau - \pi -$ echo), where T is a variable delay and τ is a fixed delay of 200 ns.

Inversion recovery and echo decay experiments were fit using stretched-exponential Equation S1 and Equation S2, respectively.

Equation S1.

$$I = I_0 + k_1 \exp\left[-\left(\frac{\tau}{T_1}\right)^{\beta_1}\right]$$

Equation S2.

$$I = I_0 + k_m \exp\left[-\left(\frac{2\tau}{T_m}\right)^{\beta_m}\right]$$

The temperature dependence of T_1 was modeled for 1:1000 CuPc:ZnPc and VOPc:TiOPc samples using the equation below, which includes direct, Raman, and local mode-mediated processes. As the electronic excited states in CuPc and VOPc are estimated to be much higher in energy than the Debye temperature, we do not expect an Orbach mechanism to be operative in these systems, consistent with another report.⁴

$$\frac{1}{T_1} = A_{dir} \cdot T + B_{ram} \cdot \left(\frac{T}{\theta_D}\right)^9 \cdot J_8\left(\frac{\theta_D}{T}\right) + C_{loc} \cdot \frac{e^{\Delta_{loc}/T}}{(e^{\Delta_{loc}/T} - 1)^2}$$

 A_{dir} , B_{ram} , and C_{loc} represent the coefficients for the direct, Raman, and local mode processes, respectively, θ_D is the Debye temperature (K), Δ_{loc} is the local mode energy (K), and $J_8(\theta_D/T)$ represents the transport integral, shown below.

$$J_8\left(\frac{\theta_D}{T}\right) = \int_0^{\theta_D/T} x^8 \cdot \frac{e^x}{(e^x - 1)^2} dx$$

Here we approximate the solution of the transport integral as the n-power of θ_D/T , which leads to the following equation.⁵

$$\frac{1}{T_1} = A_{dir} \cdot T + B_{ram} \cdot \left(\frac{T}{\theta_D}\right)^n + C_{loc} \cdot \frac{e^{\Delta_{loc}/T}}{(e^{\Delta_{loc}/T} - 1)^2}$$

We acknowledge the limitations of this phenomenological fitting. As addressed by others previously, this equation is not well fit using a least-squares minimization procedure, as each process contributes differently at different temperatures and some parameters are correlated.⁶ We begin by fitting the data to a Raman process. The power dependence of the Raman process may first be estimated from the slope of the log-log plot of the spin-lattice relaxation rates, using $log(1/T_1) = n \cdot log(T)$. A rough approximation of the Raman function was achieved by a least-squares minimization by manually adjusting parameters until a reasonable combination of Raman coefficient and Debye temperature was obtained. Debye temperatures for copper(II) and vanadyl complexes have typically been found to be less than 130 K.⁴ The Raman parameters were then fixed, and the local mode function was added to the fit. The local mode coefficient and energy were then varied until a reasonable fit was achieved. This process of fixing the parameters of one process while adjusting the parameters of the other was iterated until an optimal fit was achieved. Finally, a direct process was added and the direct coefficient was manually increased until the low-temperature data points were fit.

B.3 Powder X-Ray Diffraction

All powder X-ray diffraction (PXRD) patterns were collected on an Analytical X'Pert Pro diffractometer with a Cu source at 40 kV and 40 mA. Data were collected from 5° -40° 2 θ .



Figure B.1 (**A**) Comparison between PXRD patterns of VOPc:TiOPC at concentrations of 1:1000 (top), 1:100 (middle), and simulated Type II VOPc (bottom). (**B**) Comparison between the PXRD patterns of CuPc:ZnPc 1:1000 (top), 1:100 (middle), and simulated β -CuPc (bottom).

The PXRD patterns of both the 1:1000 and 1:100 VOPc:TiOPc mixtures shown in Figure S1 are consistent with previously reported diffraction data for the type-II polymorph and are well reproduced by simulation. This indicates structural phase homogeneity of the vanadyl samples. The PXRD patterns of the 1:1000 and 1:100 CuPc:ZnPc dispersions show distinct patterns between samples and do not strictly match either the reported α - or β -CuPc diffraction patterns.⁷



Figure B.2 Comparison between CW X-band EPR at 77 K to pseudo-modulated echo-detected field sweeps (PM-EDFSs) and the associated field sweeps at 5 K (black) and 60 K (red) of (A) VOPc 1:1000 and (B) 1:100. The additional radical species is indicated by an arrow.

	1:1000 VOPc:TiOPc	1:100 VOPc:TiOPc
g	1.968	1.968
g⊥	1.988	1.988
A _∥ (MHz)	478.6	473.6
A (cm ⁻¹)	160 x 10 ⁻⁴	158 x 10 ⁻⁴
A _⊥ (MHz)	167.6	167.9
A_{\perp} (cm ⁻¹)	56 x 10 ⁻⁴	56 x 10 ⁻⁴

Table B.1 Best-fit parameters of the simulated EPR spectra in Figure S2 used to reproduce the EPR spectra T = 77 K.

The CW-EPR of the 1:1000 and 1:100 samples of VOPc are similar. The 1:100 sample exhibits slightly broader features, presumably due to increased dipolar interactions with other vanadyl species at this higher concentration. The EDFSs of the two dilutions at both 5 K and 60 K are similar and consistent with literature reports. The PM-EDFS spectra lack the sharp radical feature present in the CW EPR (although it may slightly appear in the 1:100 spectrum), indicating that the spins responsible for this signal relax significantly slower than the shot repetition time of the spin-echo detection experiment. This feature has previously been attributed to organic radical impurities that are consistently found even in diamagnetic phthalocyanine matrices.^{2,8}



Figure B.3 Echo-detected EPR X-band field sweeps of (**A**) VOPc:TiOPc 1:1000 and (**B**) 1:100 at 5 K, 60 K, and 300 K. Dashed lines indicate field positions where relaxation data were collected. Comparison between the field position dependent behavior of the T_1 and T_m relaxation times from 5 to 300 K of VOPc:TiOPc (**C**) 1:1000 and (**D**) 1:100.



Figure B.4 EDFS EPR Q-band of (**A**) VOPc 1:1000 at 5 K, 10 K, and 60 K. Dashed lines indicate field positions where relaxation data was collected. Comparison of the field position dependent behavior of the T_1 and T_m relaxation times from 5 to 300 K of VOPc (**B**) 1:1000.



Figure B.5 Comparison between CW-EPR at 77 K to PM-EDFSs and the associated field sweeps at 5 K (black) and 60 K (blue) of (**A**) CuPc:ZnPc 1:1000 and (**B**) 1:100.

	1:1000 CuPc:ZnPc	1:100 CuPc:ZnPc
g	2.047	2.049
g⊥	2.185	2.172
A _{Cu} (MHz)	655.0	646.5
$A_{Cu\parallel}(cm^{-1})$	218 x 10 ⁻⁴	216 x 10 ⁻⁴
A _{Cu⊥} (MHz)	35.3	15.2
A _{Cu} (cm ⁻¹)	12 x 10 ⁻⁴	5 x 10 ⁻⁴
$A_{N\perp}(MHz)$	45	45-50
$A_{N\perp}$ (cm ⁻¹)	15 x 10 ⁻⁴	15-17 x 10 ⁻⁴
A _{N∥} (MHz)	45	40-48
$A_{N\parallel}$ (cm ⁻¹)	15 x 10 ⁻⁴	13-16 x 10 ⁻⁴

Table B.2 Best-fit parameters of the simulated EPR spectra in Figure S5 used to reproduce the EPR spectra T = 77 K.



Figure B.6 Echo-detected EPR Q-band field sweeps of (A) CuPc 1:1000 and (B) 1:100 from 5 K to 180 K. Dashed lines indicate field positions where relaxation data were collected. Comparison between the field position dependent behavior of the T_1 and T_m relaxation times from 5 to 180 K of CuPc (C) 1:1000 and (D) 1:100. (*) denotes the sharp radical-like feature at 1204 mT is due to a background signal in the Q-band resonator.



Figure B.7 Inversion recoveries and associated fits (pink) of **(A)** CuPc 1:1000 and **(B)** VOPc 1:1000 from at X-band. Hahn echo and associated fits (pink) of **(C)** CuPc 1:1000 and **(D)** VOPc 1:1000 from at X-band. Due to large ESEEM modulations in VOPc, we have only displayed 3 normalized traces: 5 K, 180 K, and 300K.



Figure B.8 3D-comparison between the field position dependent behavior of the CuPc 1:1000 T_1 and T_m relaxation times at X-(**A and B**) and Q- (**C and D**) band.



Figure B.9 3D-comparison between the field position dependent behavior of the VOPc 1:1000 T_1 and T_m relaxation times at X- (A and B) and Q- (C and D) band.

VOPc 1:1000	303	3 mT	329	9 mT	335.6 mT		386 mT	
Temperature (K)	T ₁ (μs)	T _m (μs)	Τ ₁ (μs)	T _m (μs)	T ₁ (μs)	T _m (μs)	Τ ₁ (μs)	T _m (μs)
5	8.2·10 ³	2.7	3.3·10 ³	3.4	4.9·10 ³	2.9	9.6·10 ³	2.6
10	3.6·10 ³	3.1	1.8·10 ³	4.0	2.4·10 ³	3.4	4.2·10 ³	2.9
25	1.4·10 ³	3.2	8.7·10 ²	4.3	1.1·10 ³	3.6	1.5·10 ³	3.2
40	$6.4 \cdot 10^2$	3.2	$3.4 \cdot 10^2$	4.5	5.0·10 ²	3.7	6.2·10 ²	3.1
60	1.9·10 ²	3.1	8.8·10 ¹	4.4	1.3·10 ²	3.6	$1.7 \cdot 10^2$	2.9
80	6.5·10 ¹	2.9	2.9·10 ¹	4.0	4.2·10 ¹	3.4	6.1·10 ¹	2.7
100	3.5·10 ¹	2.6	$1.4 \cdot 10^{1}$	3.7	2.1·10 ¹	3.3	3.3·10 ¹	2.4
110	3.1·10 ¹	2.5	1.2·10 ¹	3.6	1.8·10 ¹	3.2	2.7·10 ¹	2.3
150	1.7·10 ¹	2.1	5.5	3.1	8.5	2.8	1.3·10 ¹	2.0
180	$1.1.10^{1}$	1.8	3.4	2.7	5.4	2.6	9.6	1.6
300	3.4	_	0.8	1.4	1.3	1.5	2.9	_

Table B.3 1:1000 VOPc:TiOPc temperature-dependent T_1 and T_m data collected at selected field positions at X-band.

VOPc 1:1000	1197	7.5 mT	1214 mT		1218 mT		1265.5 mT	
Temperature (K)	Τ ₁ (μs)	T _m (μs)	Τ ₁ (μs)	T _m (μs)	T ₁ (μs)	T _m (µs)	Τ ₁ (μs)	T _m (μs)
5	9.3·10 ³	0.8	8.2·10 ³	0.5	$1.2 \cdot 10^4$	3.5	8.1·10 ³	0.5
10	4.7·10 ³	1.0	3.8·10 ³	0.5	6.3·10 ³	5.4	3.7·10 ³	0.6
25	1.5·10 ³	1.1	1.2·10 ³	0.5	2.0·10 ³	6.6	1.2·10 ³	0.8
40	5.7·10 ²	1.4	5.5·10 ²	0.4	1.0·10 ³	6.3	5.3·10 ³	0.6
60	2.0·10 ²	1.2	1.8·10 ²	0.5	4.9·10 ²	7.0	1.6·10 ²	0.6
80	9.0·10 ¹	1.0	7.3·10 ¹	0.5	3.9·10 ²	6.5	6.4·10 ²	0.6
100	5.6·10 ¹	1.3	4.1·10 ¹	0.5	6.0·10 ²	5.8	4.1·10 ²	0.5
110	$4.4.10^{1}$	1.1	3.0·10 ¹	0.5	5.1·10 ²	6.0	3.1·10 ¹	0.5
150	2.0·10 ¹	0.7	1.4·10 ¹	0.5	2.0·10 ²	4.7	1.4·10 ¹	0.4
180	1.5·10 ¹	0.7	1.0·10 ¹	0.5	8.4·10 ¹	3.6	1.2·10 ²	0.2
300	3.6	0.2	1.8	0.2	2.8	0.6	2.9	0.2

Table B.4 1:1000 VOPc:TiOPc temperature-dependent T_1 and T_m data collected at selected field positions at Q-band.

VOPc 1:100	303	3 mT	329	9 mT	335.6 mT		386 mT	
Temperature (K)	Τ ₁ (μs)	T _m (μs)	Τ ₁ (μs)	T _m (μs)	T ₁ (μs)	T _m (µs)	Τ ₁ (μs)	T _m (μs)
5	1.0·10 ³	0.9	6.3·10 ²	1.0	9.3·10 ²	1.2	1.0·10 ³	0.8
10	6.6·10 ²	0.9	4.6·10 ²	1.2	6.2·10 ²	1.3	6.8·10 ²	0.9
25	4.1·10 ²	0.9	3.0·10 ²	1.2	3.9·10 ²	1.3	4.1·10 ²	0.9
40	2.9·10 ²	0.9	2.0·10 ²	1.2	2.7·10 ²	1.3	2.8·10 ²	0.9
60	1.3·10 ²	0.9	6.9·10 ¹	1.2	1.0·10 ²	1.3	1.2·10 ²	0.9
80	5.4·10 ¹	0.9	2.7·10 ¹	1.2	4.2·10 ¹	1.3	5.2·10 ¹	0.8
100	2.8·10 ¹	0.8	1.2·10 ¹	1.1	2.0·10 ¹	1.3	2.8·10 ¹	0.7
110	2.5·10 ¹	0.8	1.0·10 ¹	1.1	1.7·10 ¹	1.2	2.3·10 ¹	0.7
150	9.3	0.6	3.5	0.9	5.7	1.1	8.9	0.5
180	8.1	0.6	2.8	0.8	4.4	1.1	7.0	0.4
300	2.7	0.3	0.8	0.4	1.3	0.6	1.7	0.1

Table B.5 1:100 VOPc:TiOPc temperature-dependent T_1 and T_m data collected at selected field positions at X-band.

CuPc 1:1000	306	б mT	329	9 mT	339 mT		342 mT	
Temperature (K)	Τ ₁ (μs)	T _m (μs)	T ₁ (μs)	T _m (μs)	T ₁ (μs)	T _m (μs)	T ₁ (μs)	T _m (μs)
5	1.6·10 ⁵	4.4	$8.3 \cdot 10^4$	$1.0.10^{1}$	$1.5 \cdot 10^4$	0.7	$5.1 \cdot 10^4$	5.0
10	$1.7 \cdot 10^4$	5.5	$1.5 \cdot 10^4$	1.8·10 ¹	5.6·10 ³	0.8	$1.3 \cdot 10^4$	8.1
25	7.4·10 ²	1.8	6.7·10 ²	5.0	5.0·10 ²	0.9	6.8·10 ²	3.5
40	1.3·10 ²	1.4	1,1·10 ²	3.4	9.7·10 ¹	1.0	1.2·10 ²	2.5
60	1.9·10 ¹	1.1	1.5·10 ¹	2.3	1.5·10 ¹	1.0	$1.7 \cdot 10^{1}$	1.9
80	5.1	0.9	3.9	1.5	4.0	0.8	4.5	1.3
100	2.0	0.7	1.5	0.9	1.5	0.5	1.7	0.9
110	1.9	0.6	1.2	0.8	1.2	0.5	1.3	0.8
150	0.7	0.4	0.4	0.5	0.5	0.3	0.5	0.4
180	_	_	0.3	0.4	0.3	0.3	0.3	0.4

Table B.6 1:1000 CuPc:ZnPc temperature-dependent T_1 and T_m data collected at selected field positions at X-band.

CuPc 1:1000	1120 mT		1188 mT		1190 mT	
Temperature (K)	Τ ₁ (μs)	T _m (µs)	Τ ₁ (μs)	T _m (µs)	Τ ₁ (μs)	T _m (µs)
5	$5.3 \cdot 10^4$	7.9	$5.0.10^4$	8.9	$5.1 \cdot 10^4$	9.0
25	6.0·10 ²	3.0	5.8·10 ²	4.4	5.9·10 ²	4.7
40	$1.1 \cdot 10^2$	1.9	9.2·10 ¹	3.1	9.3·10 ¹	3.3
80	4.9	0.7	2.8	1.3	2.8	1.4
100	1.7	0.7	1.1	1.1	1.1	1.2
110	1.4	0.6	0.8	0.9	0.8	0.9
150	_	—	0.3	0.5	0.4	0.5

Table B.7 1:1000 CuPc:ZnPc temperature-dependent T_1 and T_m data collected at selected field positions at Q-band.

CuPc 1:100	306	б mT	329	329 mT 339 mT		339 mT 342 mT		?mT
Temperature (K)	Τ ₁ (μs)	T _m (μs)	T ₁ (μs)	T _m (μs)	T ₁ (μs)	T _m (μs)	T ₁ (μs)	T _m (μs)
5	$1.2 \cdot 10^4$	1.4	2.7·10 ³	1.1	3.7·10 ³	1.5	5.6·10 ³	1.5
10	5.5·10 ³	1.4	1.9·10 ³	1.2	2.4·10 ³	1.5	3.7·10 ³	1.5
25	6.0·10 ²	1.3	4.0·10 ²	1.2	4.7·10 ²	1.5	5.6·10 ²	1.5
40	1.2·10 ²	1.2	8.9·10 ¹	1.1	9.5·10 ¹	1.4	1.1·10 ²	1.3
60	2.0·10 ¹	0.9	$1.4 \cdot 10^{1}$	0.9	$1.4.10^{1}$	1.1	1.5·10 ¹	1.0
80	5.3	0.7	3.9	0.7	3.7	0.7	4.1	0.7
100	2.5	0.5	1.7	0.5	1.6	0.5	1.8	0.5
110	1.7	0.4	1.2	0.4	1.2	0.5	1.3	0.5
150	0.8	0.3	0.5	0.3	0.5	0.3	0.5	0.3
180	_	_	0.3	0.2	0.3	0.2	0.3	0.2

Table B.8 1:100 CuPc:ZnPc temperature-dependent T_1 and T_m data collected at selected field positions at X-band.

CuPc 1:100	1120 mT		118	1188 mT		0 mT
Temperature (K)	Τ ₁ (μs)	T _m (µs)	T ₁ (μs)	T _m (µs)	T ₁ (μs)	T _m (µs)
5	$1.36 \cdot 10^4$	5.5	1.1·10 ³	3.2	1.0·10 ³	2.9
25	4.8·10 ²	2.8	2.9·10 ²	1.9	3.0·10 ²	1.8
40	1.0·10 ²	1.8	7.0·10 ¹	1.6	7.0·10 ¹	1.5
80	4.9	0.6	2.6	0.7	2.6	0.7
100	1.7	0.5	1.0	0.5	0.9	0.5
110	1.5	0.4	0.7	0.4	0.8	0.4
150	0.6	0.2	0.3	0.2	0.3	0.2
180	_	_	0.3	0.2	0.2	0.2

Table B.9 1:100 CuPc:ZnPc temperature-dependent T_1 and T_m data collected at selected field positions at Q-band.



Figure B.10 Comparison stretching term, β , for VOPc 1:1000 at 335.6 mT (red) and CuPc 1:1000 at 329 mT (blue) (**A**) T_1 times (β_1) and (**B**) T_m times (β_m).



Figure B.11 (A) Comparison of the PXRD pattern of an independent preparation of CuPc:ZnPc. (B) Echo-detected EPR X-band field sweeps of CuPc at 5 K, 10 K, and 60 K. Dashed lines indicate field positions where relaxation data were collected. (C) Comparison of the field position dependent behavior of the T_1 and T_m relaxation times from 5–180 K of CuPc dilution. (D) Comparison between X-band T_1 and T_m times vs. temperature for the 329 mT features in CuPc at X- and Q-band for the 1:1000, 1:100 preparations and the independent preparation.

A CuPc:ZnPc sample was prepared to yield a final dilution of 1:1000 by an independent method analogous to the preparation for VOPc:TiOPc samples using DCM/CF₃CO₂H/IPA. Due to solubility issues in the preparation of this CuPc:ZnPc sample, the final concentration is unknown. The PXRD patterns are distinct from the 1:1000 and 1:100 previously prepared (Figure S11A). However, the CW-EPR spectrum shows similar copper features despite a significantly more intense radical signal (Figure S12). As well, the T_1 and T_m temperature-dependences observed for this sample were consistent with the other CuPc samples when measured at 306, 329,

and 342 mT (Figure S11). This preparation method did, however, display substantially different behavior with respect to the 339 mT field position. In the EDFS, there is a sharp signal at 339 mT. The T_1 times measured at this position remained significantly longer at higher temperatures than for other field positions, whereas the T_m times of this feature were found to be lower than at the other positions. These observations indicate that this signal arises from the organic radical. In contrast to the samples prepared by the sulfuric acid method, the EDFS spectra do not change much with increasing temperature. The distinct temperature dependences in the EDFS spectra, T_1 , and T_m times between the various preparations indicate that the radical species may be delocalized in different ways in these two samples. When monitoring relaxation behavior at field positions not associated with the radical (e.g., 306, 329 mT at X-band), then similar temperature-dependent trends are observed regardless of sample preparation method or concentration (Figure S11D). This suggests that the radical is not the dominant feature contributing to the differences in relaxation times between VOPc and CuPc mixtures.



Figure B.12 (A) Comparison of CW-EPR at 77 K of the CuPc:ZnPc 1:100 and 1:1000 and independent preparations. (B) Zoom-in to show ^{14}N superhyperfine features.

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