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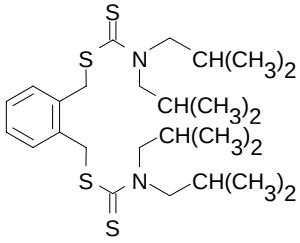
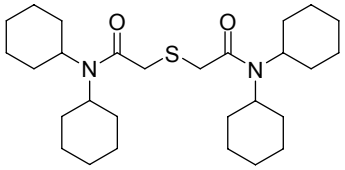
Copper



Copper(II) ionophore I

(*o*-Xylene-bis-(*N*,*N*-diisobutyldithiocarbamate))
$C_{26}H_{44}N_2S_4$ M_r 512.89 [125769-67-7]

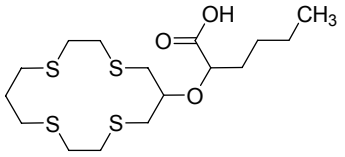
61193 **Selectophore®, function tested** 50 mg



Copper(II) ionophore IV

(N,N,N',N'-tetracyclohexyl-3-thiaglutaric diamide)
$C_{28}H_{48}N_2O_2S$ M_r 476.76

50242 **Selectophore®, function tested** 10 mg, 100 mg



Copper(II) ionophore V

(2-(1,4,8,11-Tetrathiacyclotetradec-6-yloxy)hexanoic acid; TTCT-OHA)
$C_{16}H_{30}O_3S_4$ M_r 398.67 [162316-51-0]

38788 **Selectophore®, function tested** 50 mg, 250 mg

Electrochemical Transduction

- Ion-Selective Electrodes

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Electrochemical Transduction

Ion-Selective Electrodes

Application 1 and Sensor Type [1]

Lipophilic neutral carrier (ionophore) as copper sensing material in ion-selective polymer membrane electrodes; rejecting the interference alkali, alkaline earth and transition metal cations, and showing a high selectivity for Cu^{2+} even in chloride and bromide media.

Recommended Membrane Composition

6.90	wt%	Copper(II) ionophore I (61193)
34.30	wt%	2-Nitrophenyl octyl ether (73732)
1.60	wt%	Potassium tetrakis(4-chlorophenyl)borate (60591)
57.20	wt%	Poly(vinyl chloride) high molecular weight (81392)

Recommended Cell Assembly

Reference ‖ sample solution ‖ liquid membrane | 0.001 M $CuCl_2$ | AgCl, Ag

Electrode Characteristics and Function

Selectivity coefficients $\log K^{Pot}_{Cu,M}$ as obtained by the mixed solution method (concentration of the interfering ions are: 10^{-2} M for alkaline earth cations and transition metal ions and 10^{-1} M for alkali cations).

$\log K^{Pot}_{Cu,Pb}$	-0.75	$\log K^{Pot}_{Cu,Ni}$	-3.2
$\log K^{Pot}_{Cu,Zn}$	-2.25	$\log K^{Pot}_{Cu,Ca/Mg}$	-3.6
$\log K^{Pot}_{Cu,K}$	-2.35	$\log K^{Pot}_{Cu,Sr}$	-3.7
$\log K^{Pot}_{Cu,Mn}$	-2.5	$\log K^{Pot}_{Cu,Co}$	-4.0
$\log K^{Pot}_{Cu,Na}$	-2.65	$\log K^{Pot}_{Cu,Cd}$	-4.4

Slope of linear regression: 28-29 mV/dec (10^{-6} to 10^{-1} M $CuCl_2$; pH range: 3.2-5.5)
Detection limit: $1.4 \cdot 10^{-7}$ M Cu^{2+}
Response time: 9 s (10^{-3} to 10^{-2} M Cu^{2+})

[1] S. Kamata, H. Murata, Y. Kubo, A. Bhale, Copper(II)-selective membrane electrodes based on o-xylylene bis(dithiocarbamates) as neutral carriers. **Analyst *114***, 1029 (1989).

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Application 2 and Sensor Type [2]

The Copper(II) ionophore is especially suitable for monitoring drinking water, since the common ions in drinking water such as Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} don't interfere with the measurement, even if they are present in very high concentrations.

Recommended Membrane Composition

Conventional membrane (Conv):

0.47	wt%	Copper(II) ionophore (50242)
0.43	wt%	Tetrakis[3,5-bis(trifluoromethyl)phenyl]borate (72017)
65.90	wt%	2-Nitrophenyl octyl ether (73732)
33.20	wt%	Poly(vinyl chloride) high molecular weight (81392)

Harder membrane (Hard):

0.53	wt%	Copper(II) ionophore (50242)
0.43	wt%	Tetrakis[3,5-bis(trifluoromethyl)phenyl]borate (72017)
55.68	wt%	2-Nitrophenyl octyl ether (73732)
43.36	wt%	Poly(vinyl chloride) high molecular weight (81392)

Recommended Cell Assembly

Reference | | sample solution | | liquid membrane | 10^{-4} M $Cu(NO_3)_2$ | AgCl, Ag

Electrode Characteristics and Function

Selectivity coefficients $\log K^{Pot}_{Cu,M}$ as obtained by the separate solution method.

	Conv	**Hard**
$\log K^{Pot}_{Cu,H}$	-0.44	-0.65
$\log K^{Pot}_{Cu,Na}$	< -4.61	< -5.67
$\log K^{Pot}_{Cu,K}$	< -4.74	< -5.44
$\log K^{Pot}_{Cu,Ag}$	2.96	3.52
$\log K^{Pot}_{Cu,Et_4N}$	2.48	2.10
$\log K^{Pot}_{Cu,Mg}$	< -6.26	< -6.91
$\log K^{Pot}_{Cu,Ca}$	-4.64	-4.65
$\log K^{Pot}_{Cu,Zn}$	-2.67	-1.95
$\log K^{Pot}_{Cu,Cd}$	-3.34	-3.50
$\log K^{Pot}_{Cu,Pb}$	-1.82	-1.79

Slope of linear regression: 33 mV/dec ($2 \cdot 10^{-7}$ to 10^{-1} M $Cu(NO_3)_2$)
Detection limit: $2 \cdot 10^{-9}$ M Cu^{2+} (low ionic background)
$1 \cdot 10^{-7}$ M Cu^{2+} (high ionic background)
Response time: <60 s (≥10^{-6} M Cu^{2+})
10 min (<10^{-6} M Cu^{2+})
Life span: 8 weeks

[2] Z. Szigetti, I. Bitter, K. Tóth, C. Latkoczy, D. Fliegel, D. Günther, E. Pretsch. A novel polymeric membrane electrode for the potentiometric analysis of Cu^{2+} in drinking water, **Anal. Chim. Acta *532***, 129 (2005).

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Application 3 and Sensor Type [3]
Assay of Cu^{2+} activity with polymer matrix ion-selective electrode and ion-selective field effect transistors (ISFET) of good durability based on Copper(II) ionophore V at pH 5.3-7.2.

Recommended Membrane Composition

3.2	wt%	Copper(II) ionophore V (38788)
66.7	wt%	Bis(2-ethylhexyl) phthalate (DOP) (80032)
30.1	wt%	Poly(vinyl chloride) high molecular weight (81392)

Recommended Cell Assembly
Ag,AgCl, KCl (3M) | 1.0 M CH_3COOLi || sample solution || PVC membrane | $1 \cdot 10^{-3}$ M $Cu(NO_3)_2$ | AgCl, Ag

Electrode Characteristics and Function

Selectivity coefficients $\log K^{Pot}_{Cu,M}$ as obtained by the fixed interference method (FIM) (concentration of the interfering ions are $1.0 \cdot 10^{-3}$ M except for Ag^+ ($1.0 \cdot 10^{-4}$ M)).

$\log K^{Pot}_{Cu,Ag}$	0.0	$\log K^{Pot}_{Cu,Fe(III)}$	-4.9
$\log K^{Pot}_{Cu,Ni}$	-4.2	$\log K^{Pot}_{Cu,Mn}$	-5.2
$\log K^{Pot}_{Cu,Co}$	-5.2	$\log K^{Pot}_{Cu,Cd}$	-4.3
$\log K^{Pot}_{Cu,Zn}$	-4.7		

Slope of linear regression: 33.5 mV/dec ($1 \cdot 10^{-6}$ to $1 \cdot 10^{-3}$ M $CuCl_2$; pH range: 5.3-7.2)
Detection limit: $8 \cdot 10^{-7}$ M Cu^{2+}
Response time: 9 s (10^{-3} to 10^{-2} M Cu^{2+})

[3] S. Wakida, N. Sato, K. Saito, A. Bhale, Copper(II)-selective electrodes based on a novel charged carrier and preliminary application of field-effect transistor type checker. **Sensors and Actuators B *130***, 187 (2008).