

Supporting Information

Locally Engineering and Interrogating the Photoelectrochemical Behavior of Defects in Transition Metal Dichalcogenides

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Details on Finite Element Simulations

Potential Profiles within Nanosheets

Potential profiles within individual thin nanosheets were simulated using a 3D model in COMSOL Multiphysics. The simulation geometry employed is depicted schematically in **Figure 6** in the main text. Potential profiles were first found by solving the Poisson-Boltzmann equation:

$$\nabla^2 \varphi = \frac{q n_D}{\epsilon \epsilon_0} \left[1 - e^{-\frac{q \varphi}{k_b T}} \right] \quad S1$$

Here, φ is the potential, q is the elementary unit of charge, n_D is the dopant density, ϵ is the dielectric constant of the nanosheet, ϵ_0 is the permittivity, and $k_b T$ is Boltzmann's constant times temperature. The following boundary conditions were employed in these simulations:

$$\varphi(z = 0) = 0 \quad S2$$

$$\varphi(r < r_p, z = w_p) = E_{fb} - E \quad S3$$

Here, w_p is the nanosheet thickness at the point of pipet contact (either within a hole defect or on the basal plane), r_p is the pipet radius, and $E_{fb} - E$ represents the applied potential with respect to the flatband potential. Solutions to these equations yielded potential profiles within the layers.

Photocurrents at Individual Nanosheets

Photocurrents were simulated by calculating steady-state solutions to the following equation governing minority carrier transport within a p-type material:

$$\frac{\partial n_e}{\partial t} = -\nabla \cdot \vec{J} + g \quad S4$$

The flux, \vec{J} , and carrier generation rate, g , were taken to be:

$$\vec{J} = -\frac{k_b T \mu_e}{q} \nabla n_e + \mu_e n_e \nabla \varphi \quad S5$$

$$g = I_0 \alpha e^{-\alpha z} - \frac{n_e}{\tau} \quad S6$$

Here, μ_e is the electrical mobility of electrons in the semiconductor, n_e is the concentration of electrons in the semiconductor, I_0 is the incident photon flux, α is the absorption coefficient of the semiconductor, and τ is the carrier lifetime. The form for φ employed were solutions to the Poisson-Boltzmann equation described above. Solutions were found subject to the following boundary conditions:

$$j_e(r < r_p, z = w_p) = kn_e \quad S7$$

$$n_e(r = r_h, w_h < z < w_s) = 0 \quad S8$$

Here, j_e represents the electron flux, w_h represents sheet thickness within the hole defect, w_s represents sheet thickness outside of the hole defect, and r_h represents the radius of the hole defect. No-flux boundary conditions were imposed at all other interfaces. Currents were calculated from the resulting steady-state carrier profiles according to the following relation:

$$i = 2\pi q_e \int_0^{r_p} kn_e r dr \quad S9$$

Values of Physical Constants Employed in Finite Element Simulations

Table S1. Values of physical constants employed in carrier distribution/transport simulations. Subscript z's and r's denote out-of-plane and in-plane quantities, respectively. Values were selected to match well to experimental measurements or typical literature values.¹⁻⁴

Quantity	Value	Quantity	Value
ϵ_z	4	τ	100 ns
ϵ_r	13	n_D	$1 \times 10^{17} \text{ cm}^{-3}$
ϵ_0	$8.854 \times 10^{-12} \text{ F m}^{-1}$	q	$1.6 \times 10^{-19} \text{ C}$
L_z	3 μm	$k_b T$	0.026 eV
L_r	3 μm	α	$1 \times 10^5 \text{ cm}^{-1}$

Here, L refers to the electron diffusion length. This is related to the mobility utilized in the above expressions through the following relation:

$$\mu_e = \frac{q_e D}{k_b T} = \frac{q_e L^2}{k_b T \tau} \quad S10$$

Additional Experimental Data

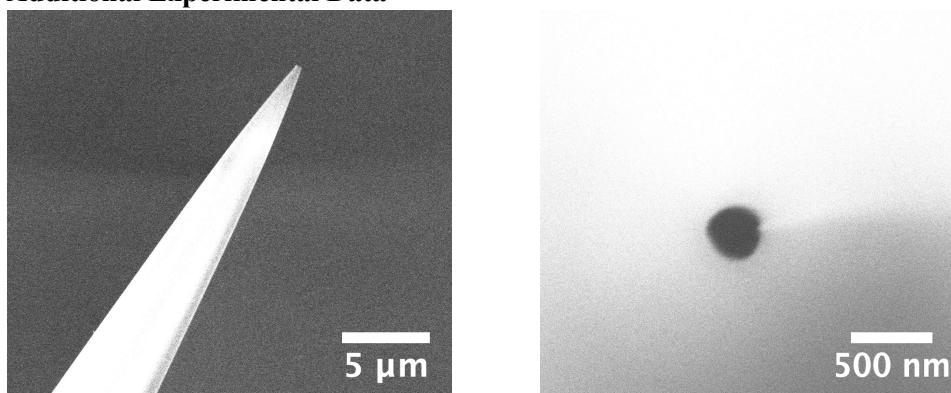


Figure S1. Representative electron microscopy images of pipets employed for SECCM imaging.

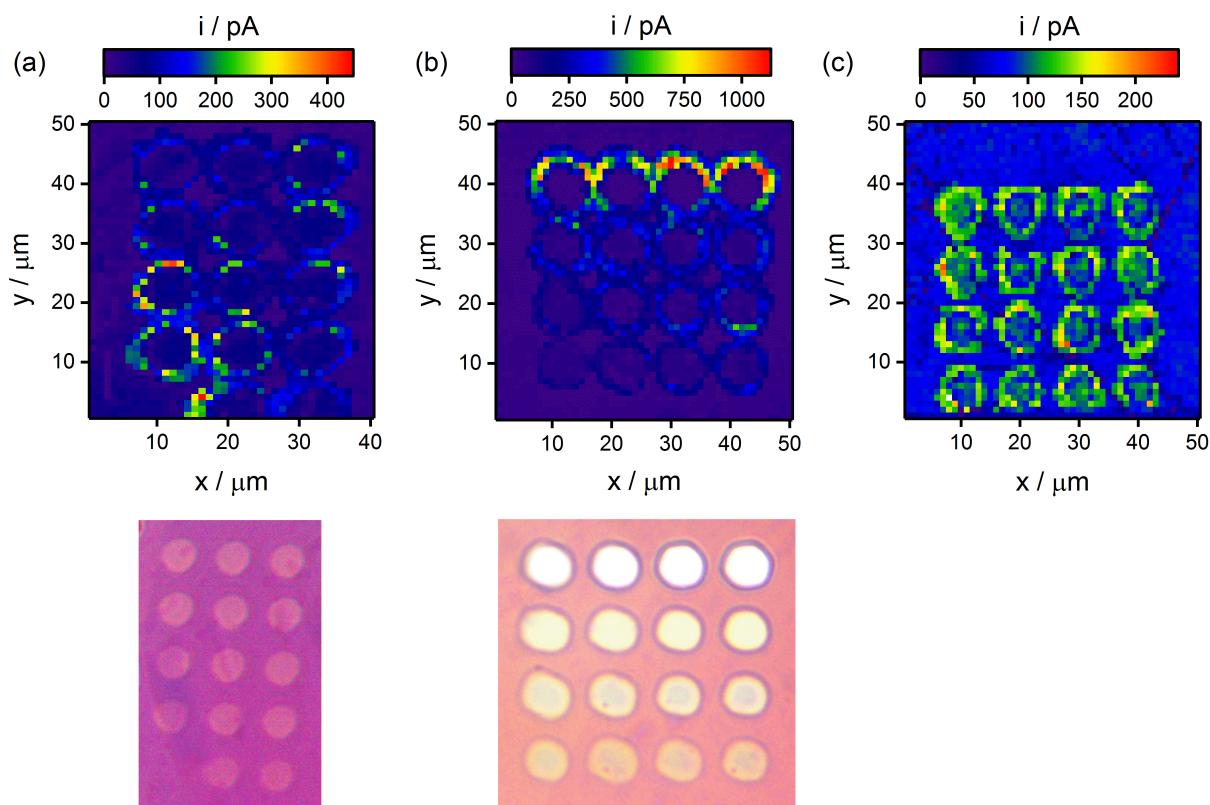


Figure S2. Additional examples of defect arrays in p-type WSe₂ nanosheets engineered and characterized via SECCM. SECCM photocurrent images are provided at -0.96 V vs. Ag/AgCl. All photoelectrochemical data were acquired in an aqueous solution containing 25 mM trisodium citrate and 25 mM citric acid. Potentials were swept from -1.0 V to 0 V vs Ag/AgCl at 2000 mV/s. Optical transmission images of the arrays are also provided, except in (c) where the sheet was too thick to permit imaging.

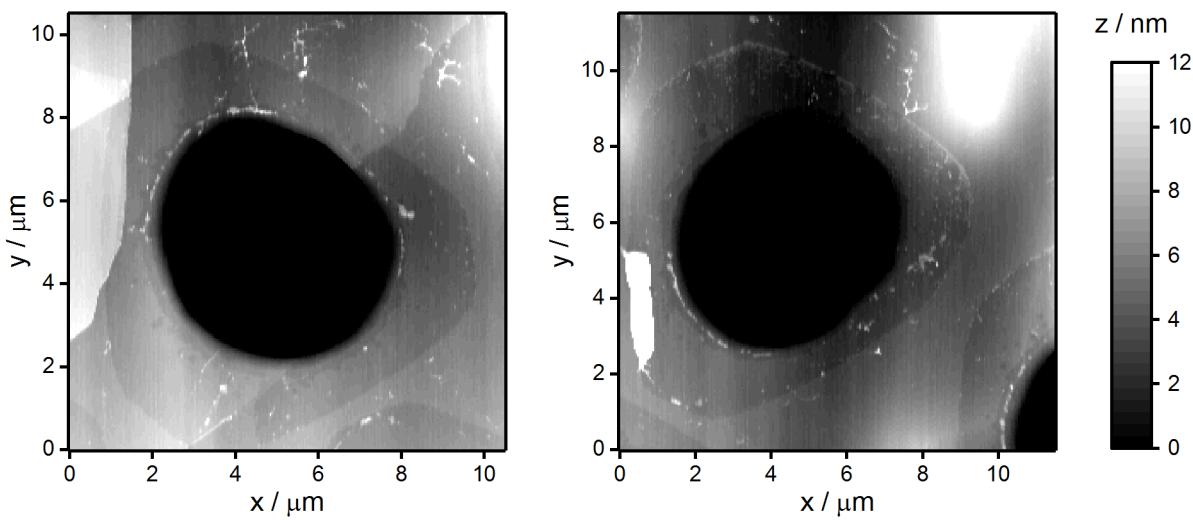


Figure S3. Lower resolution atomic force microscopy images showing anodized “rings” surrounding the engineered defects in p-type WSe₂ nanosheets.

References

- (1) Frindt, R. F. The Optical Properties of Single Crystals of WSe₂ and MoTe₂. *J. Phys. Chem. Solids* **1963**, *24* (9), 1107–1108.
- (2) Yu, X.; Sivula, K. Photogenerated Charge Harvesting and Recombination in Photocathodes of Solvent-Exfoliated WSe₂. *Chem. Mater.* **2017**, *29* (16), 6863–6875.
- (3) Velazquez, J. M.; John, J.; Esposito, D. V.; Pieterick, A.; Pala, R.; Sun, G.; Zhou, X.; Huang, Z.; Ardo, S.; Soriaga, M. P.; et al. A Scanning Probe Investigation of the Role of Surface Motifs in the Behavior of p-WSe₂ Photocathodes. *Energy Environ. Sci.* **2016**, *9* (1), 164–175.
- (4) Jakubowicz, A.; Mahalu, D.; Wolf, M.; Wold, A.; Tenne, R. WSe₂: Optical and Electrical Properties as Related to Surface Passivation of Recombination Centers. *Phys. Rev. B* **1989**, *40* (5), 2992–3000.

COMSOL Model Report

1 Global Definitions

Date	May 2, 2020 9:53:27 AM
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GLOBAL SETTINGS

Name	Anodized Sheet Sim.mph
COMSOL version	COMSOL 5.3 (Build: 316)

USED PRODUCTS

COMSOL Multiphysics

1.1 PARAMETERS 1

PARAMETERS

Name	Expression	Value	Description
ws	60[nm]	6E-8 m	
wh	23[nm]	2.3E-8 m	
rh	3[um]	3E-6 m	
rsim	40[um]	4E-5 m	
xcoll	1[um]	1E-6 m	
rcoll	0.150[um]	1.5E-7 m	
xyres	0.50[um]	5E-7 m	
xyrange	10[um]	1E-5 m	
Lz	3[um]	3E-6 m	
Lx	3[um]	3E-6 m	
tau	100[ns]	1E-7 s	
epz	4	4	
epx	13	13	
nD	1e17[1/cm^3]	1E23 1/m ³	
Eapp	0.43[V]	0.43 V	
T	300[K]	300 K	
I0	1.5e20[1/cm^2/s]	1.5E24 1/(m ² ·s)	
alpha	1e5[1/cm]	1E7 1/m	
wl	600[nm]	6E-7 m	
kbp	4.7e-5[cm/s]	4.7E-7 m/s	
zRes	2[nm]	2E-9 m	

2 Component 1

COMPONENT SETTINGS

Unit system	SI
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2.1 DEFINITIONS

2.1.1 Variables

Variables 1

SELECTION

Geometric entity level	Entire model
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Name	Expression	Unit	Description
Dx	Lx^2/τ	m^2/s	
Dz	Lz^2/τ	m^2/s	
Rg	$I_0 \cdot \alpha \cdot \exp(-\alpha \cdot z)$	$1/(m^3 \cdot s)$	
μ_x	$Dx \cdot e_{const} / (k_B \cdot const \cdot T)$	$m^2/(V \cdot s)$	
μ_z	$Dz \cdot e_{const} / (k_B \cdot const \cdot T)$	$m^2/(V \cdot s)$	

2.1.2 Probes

Global Variable Probe 1

Probe type	Global variable probe
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2.1.3 Component Couplings

Integration 1

Coupling type	Integration
Operator name	intop1

SOURCE SELECTION

Geometric entity level	Boundary
Name	Pipet Contact
Selection	Boundary 30

2.1.4 Selections

Pipet Contact

Selection type
Cylinder

Selection
Boundary 30

Domains inside Hole

Selection type
Cylinder

Selection
Domains 5–6

2.1.5 Coordinate Systems

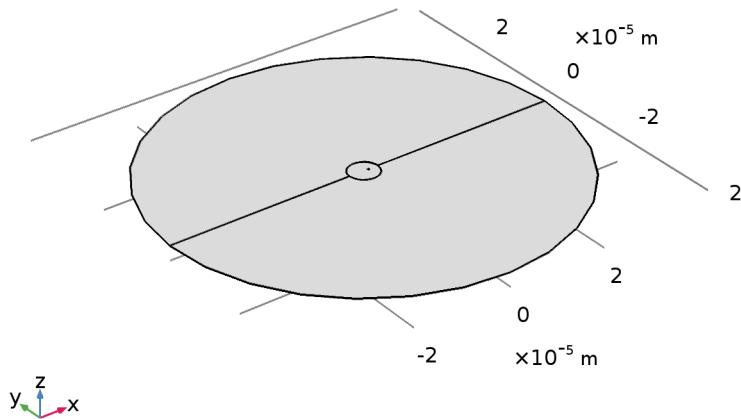
Boundary System 1

Coordinate system type	Boundary system
Tag	sys1

COORDINATE NAMES

First	Second	Third
t1	t2	n

2.2 GEOMETRY 1



Geometry 1

UNITS

Length unit	m
Angular unit	deg

GEOMETRY STATISTICS

Description	Value
Space dimension	3
Number of domains	6
Number of boundaries	34
Number of edges	58
Number of vertices	32

2.2.1 Bottom Sheet (cyl1)

POSITION

Description	Value
Position	{0, 0, 0}

AXIS

Description	Value
Axis type	z - axis

SIZE AND SHAPE

Description	Value
Radius	rsim
Height	wh

2.2.2 Top Sheet (cyl8)

POSITION

Description	Value
Position	{0, 0, wh}

AXIS

Description	Value
Axis type	z - axis

SIZE AND SHAPE

Description	Value
Radius	rsim
Height	ws - wh

2.2.3 Hole (cyl4)

POSITION

Description	Value
Position	{0, 0, 0}

AXIS

Description	Value
Axis type	z - axis

SIZE AND SHAPE

Description	Value
Radius	rh
Height	ws

2.2.4 Hole Bottom (cyl7)

POSITION

Description	Value
Position	{0, 0, 0}

AXIS

Description	Value
Axis type	z - axis

SIZE AND SHAPE

Description	Value
Radius	rh
Height	wh

2.2.5 Pipet (cyl6)

POSITION

Description	Value
Position	{xcoll, 0, 0}

AXIS

Description	Value
Axis type	z - axis

SIZE AND SHAPE

Description	Value
Radius	rcoll
Height	wh

2.2.6 Work Plane 1 (wp1)

SETTINGS

Description	Value
Plane	xz - plane

UNITE OBJECTS

Description	Value
Unite objects	On

Plane Geometry (sequence2D)

2.2.7 Partition Domains 1 (pard1)

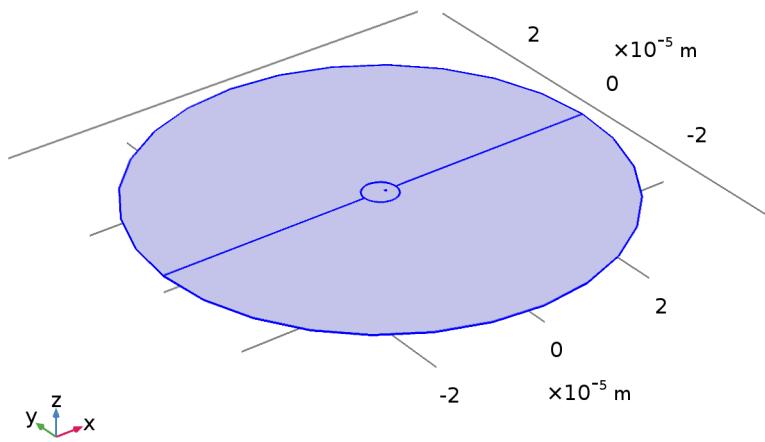
SETTINGS

Description	Value
Work plane	Work Plane 1

2.3 POTENTIAL DISTRIBUTION

USED PRODUCTS

COMSOL Multiphysics



Potential Distribution

SELECTION

Geometric entity level	Domain
Selection	Domains 1–6

SETTINGS

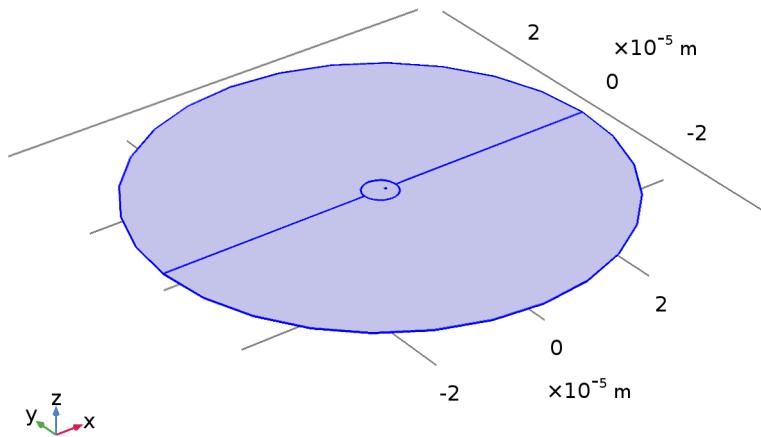
Description	Value
Shape function type	Lagrange
Element order	Quadratic
Compute boundary fluxes	On
Apply smoothing to boundary fluxes	On
Value type when using splitting of complex variables	Complex
Frame	Spatial
Dependent variable quantity	Electric potential (V)
Source term quantity	None
Unit	C/m ³

VARIABLES

Name	Expression	Unit	Description	Selection
E.nx	nx		Normal vector, x component	Boundaries 1–34
E.ny	ny		Normal vector, y component	Boundaries 1–34
E.nz	nz		Normal vector, z component	Boundaries 1–34
E.nxmesh	root.nxmesh		Normal vector (mesh), x component	Boundaries 1–34
E.nymesh	root.nymesh		Normal vector (mesh), y component	Boundaries 1–34

Name	Expression	Unit	Description	Selection
E.nzmesh	root.nzmesh		Normal vector (mesh), z component	Boundaries 1–34

2.3.1 Coefficient Form PDE 1



Coefficient Form PDE 1

SELECTION

Geometric entity level	Domain
Selection	Domains 1–6

EQUATIONS

$$e_a \frac{\partial^2 E}{\partial t^2} + d_a \frac{\partial E}{\partial t} + \nabla \cdot (-c \nabla E - \alpha E + \gamma) + \beta \cdot \nabla E + a E = f$$

$$\nabla = [\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}]$$

SETTINGS

Description	Value
Diffusion coefficient	{ {epsilon0_const*epx, 0, 0}, {0, epsilon0_const*epx, 0}, {0, 0, epsilon0_const*epx} }
Absorption coefficient	0
Source term	e_const*nD*(1 - exp(e_const*E/(k_B_const*T)))
Mass coefficient	0
Damping or mass coefficient	0
Conservative flux convection coefficient	{0, 0, 0}
Convection coefficient	{0, 0, 0}
Conservative flux source	{0, 0, 0}

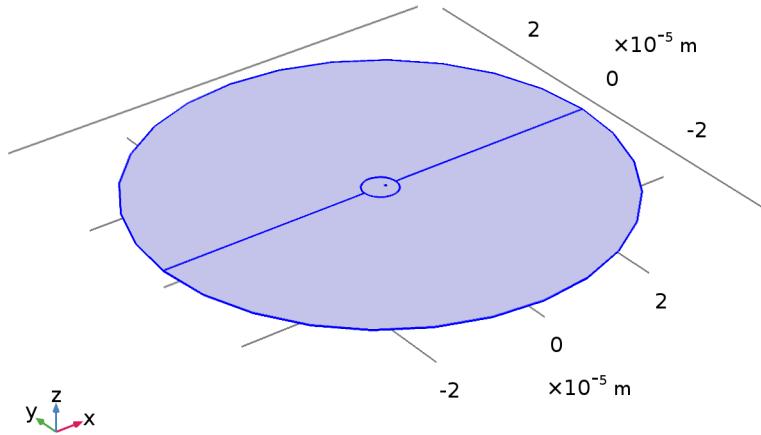
Variables

Name	Expression	Unit	Description	Selection
domflux.Ex	-epsilon0_const*epx*Ex	C/m ²	Domain flux, x component	Domains 1–6
domflux.Ey	-epsilon0_const*epx*Ey	C/m ²	Domain flux, y component	Domains 1–6
domflux.Ez	-epsilon0_const*epx*Ez	C/m ²	Domain flux, z component	Domains 1–6

Shape functions

Name	Shape function	Unit	Description	Shape frame	Selection
E	Lagrange (Quadratic)	V	Dependent variable E	Spatial	Domains 1–6

2.3.2 Zero Flux 1



Zero Flux 1

SELECTION

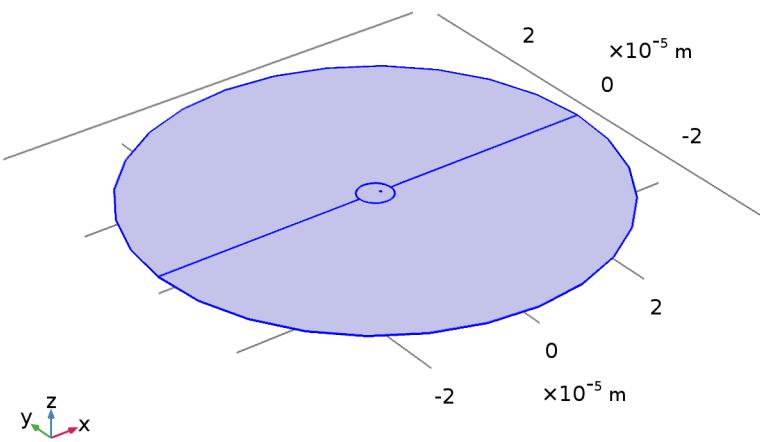
Geometric entity level	Boundary
Selection	Boundaries 2–3, 7–8, 11–12, 16–20, 22, 24–26

EQUATIONS

$$-\mathbf{n} \cdot (-c\nabla E - \alpha E + \gamma) = 0$$

$$\nabla = \left[\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z} \right]$$

2.3.3 Initial Values 1



Initial Values 1

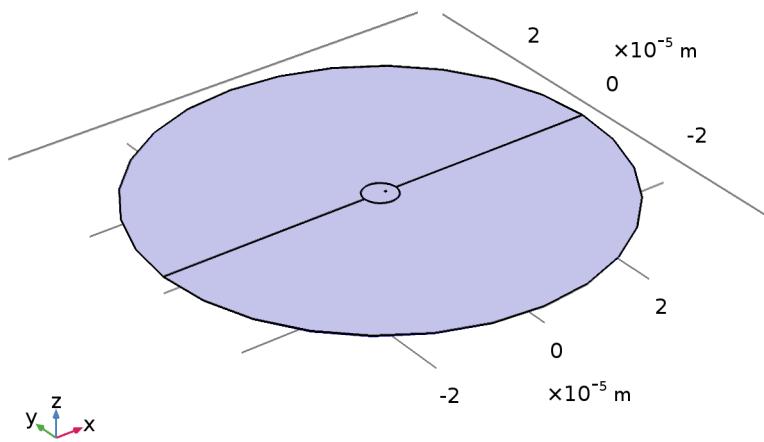
SELECTION

Geometric entity level	Domain
Selection	Domains 1–6

SETTINGS

Description	Value
Initial value for E	0
Initial time derivative of E	0

2.3.4 Dirichlet Boundary Condition 1



Dirichlet Boundary Condition 1

SELECTION

Geometric entity level	Boundary
Selection	Boundaries 4–5, 15, 29

EQUATIONS

$$E = r$$

$$g_{\text{reaction}} = -\mu$$

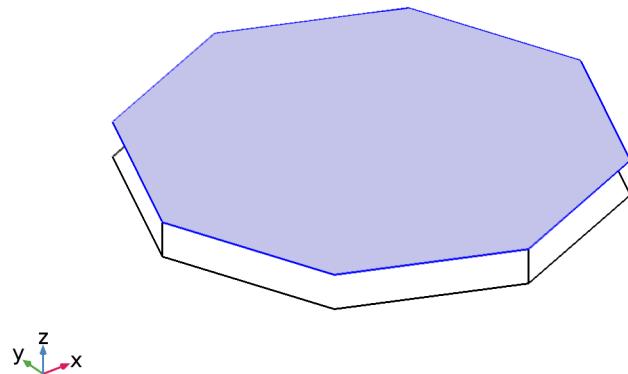
SETTINGS

Description	Value
Value on boundary	0
Prescribed value of E	On
Apply reaction terms on	Individual dependent variables
Use weak constraints	Off
Constraint method	Elemental

Shape functions

Constraint	Constraint force	Shape function	Selection
-E	-test(E)	Lagrange (Quadratic)	Boundaries 4–5, 15, 29

2.3.5 Dirichlet Boundary Condition 2



Dirichlet Boundary Condition 2

SELECTION

Geometric entity level	Boundary
Name	Pipet Contact
Selection	Boundary 30

EQUATIONS

$$E = r$$

$$g_{\text{reaction}} = -\mu$$

SETTINGS

Description	Value
Value on boundary	-Eapp
Prescribed value of E	On
Apply reaction terms on	Individual dependent variables
Use weak constraints	Off
Constraint method	Elemental

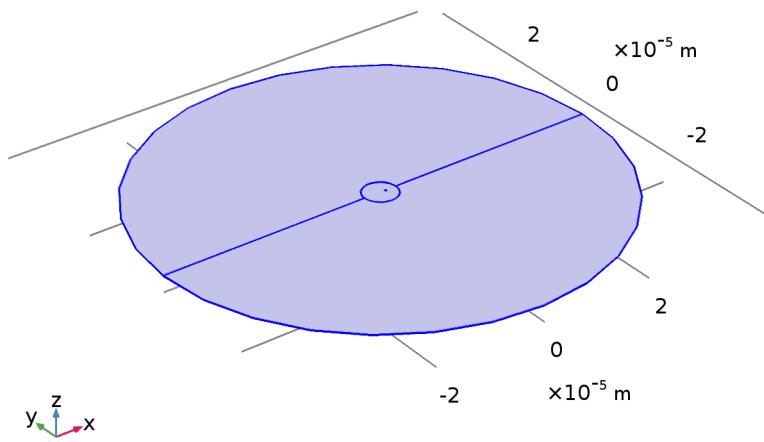
Shape functions

Constraint	Constraint force	Shape function	Selection
-Eapp-E	-test(E)	Lagrange (Quadratic)	Boundary 30

2.4 CARRIER TRANSPORT

USED PRODUCTS

COMSOL Multiphysics



Carrier Transport

SELECTION

Geometric entity level	Domain
Selection	Domains 1–6

SETTINGS

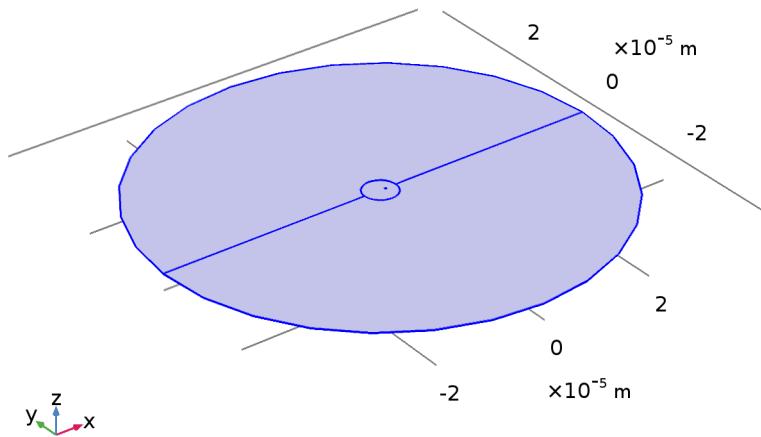
Description	Value
Shape function type	Lagrange
Element order	Quadratic
Compute boundary fluxes	On
Apply smoothing to boundary fluxes	On
Value type when using splitting of complex variables	Complex
Frame	Spatial
Dependent variable quantity	Number density (1/m ³)
Source term quantity	None
Unit	1/(m ³ *s)

VARIABLES

Name	Expression	Unit	Description	Selection
n.nx	nx		Normal vector, x component	Boundaries 1–34
n.ny	ny		Normal vector, y component	Boundaries 1–34
n.nz	nz		Normal vector, z component	Boundaries 1–34
n.nxmesh	root.nxmesh		Normal vector (mesh), x component	Boundaries 1–34
n.nymesh	root.nymesh		Normal vector (mesh), y component	Boundaries 1–34

Name	Expression	Unit	Description	Selection
n.nzmesh	root.nzmesh		Normal vector (mesh), z component	Boundaries 1–34

2.4.1 Coefficient Form PDE 1



Coefficient Form PDE 1

SELECTION

Geometric entity level	Domain
Selection	Domains 1–6

EQUATIONS

$$e_a \frac{\partial^2 nh}{\partial t^2} + d_a \frac{\partial nh}{\partial t} + \nabla \cdot (-c \nabla nh - \alpha nh + \gamma) + \beta \cdot \nabla nh + \alpha nh = f$$

$$\nabla = [\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}]$$

SETTINGS

Description	Value
Diffusion coefficient	{ {Dx, 0, 0}, {0, Dx, 0}, {0, 0, Dz} }
Absorption coefficient	1/tau
Source term	Rg
Mass coefficient	0
Damping or mass coefficient	1
Conservative flux convection coefficient	{mux*Ex, mux*Ey, muz*Ez}
Convection coefficient	{0, 0, 0}
Conservative flux source	{0, 0, 0}

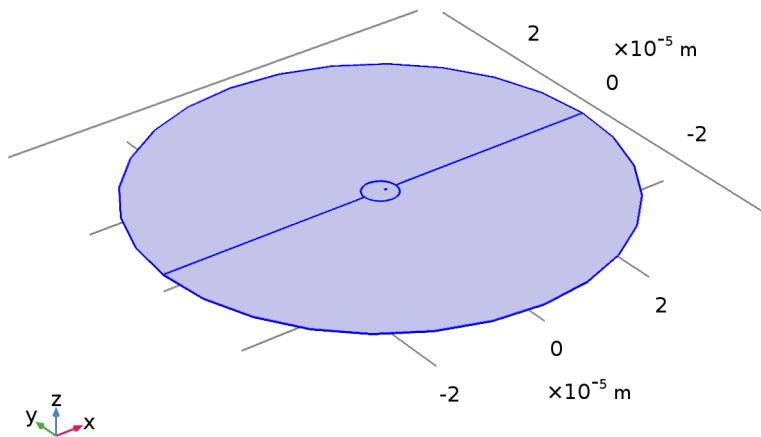
Variables

Name	Expression	Unit	Description	Selection
domflux.nex	-Dx*nex-mux*Ex*ne	1/(m ² ·s)	Domain flux, x component	Domains 1–6
domflux.ney	-Dx*ney-mux*Ey*ne	1/(m ² ·s)	Domain flux, y component	Domains 1–6
domflux.nez	-Dz*nez-muz*Ez*ne	1/(m ² ·s)	Domain flux, z component	Domains 1–6

Shape functions

Name	Shape function	Unit	Description	Shape frame	Selection
ne	Lagrange (Quadratic)	1/m ³	Dependent variable ne	Spatial	Domains 1–6

2.4.2 Zero Flux 1



Zero Flux 1

SELECTION

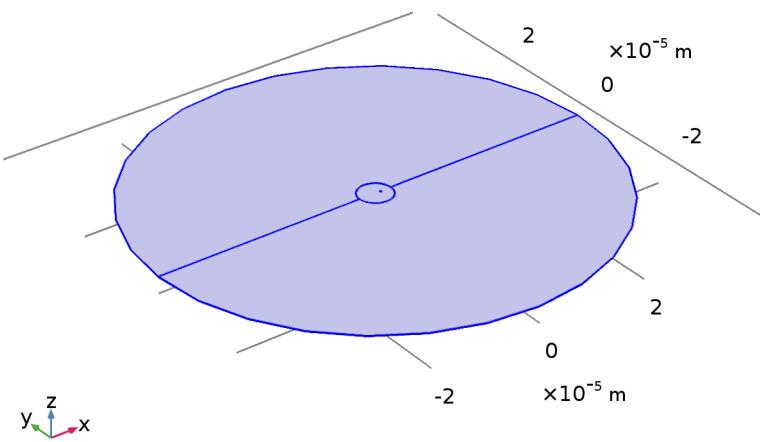
Geometric entity level	Boundary
Selection	Boundaries 2–5, 7–8, 11–12, 15, 18–20, 25–26, 29

EQUATIONS

$$-\mathbf{n} \cdot (-c\nabla nh - \alpha nh + \gamma) = 0$$

$$\nabla = \left[\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z} \right]$$

2.4.3 Initial Values 1



Initial Values 1

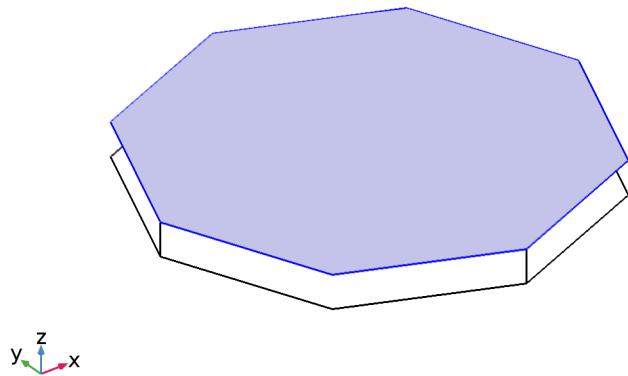
SELECTION

Geometric entity level	Domain
Selection	Domains 1–6

SETTINGS

Description	Value
Initial value for ne	$Rg * \tau$
Initial time derivative of ne	0

2.4.4 Flux/Source 1



Flux/Source 1

SELECTION

Geometric entity level	Boundary
Name	Pipet Contact
Selection	Boundary 30

EQUATIONS

$$-\mathbf{n} \cdot (-c\nabla nh - \alpha nh + \gamma) = g - qnh$$

$$\nabla = [\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}]$$

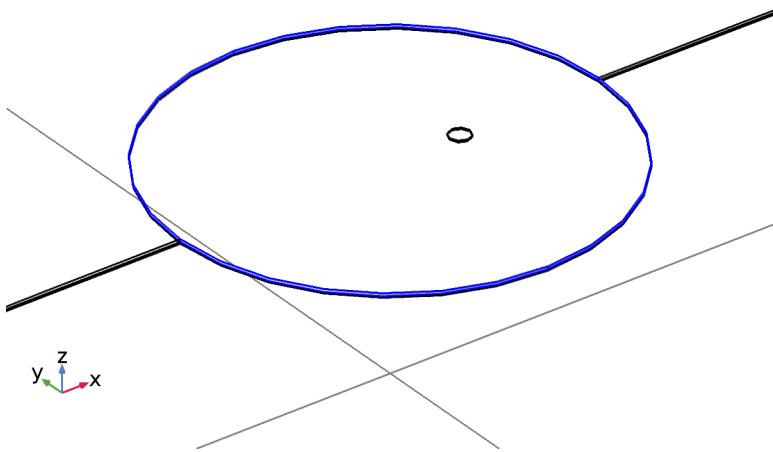
SETTINGS

Description	Value
Boundary flux/source	-kbp*ne
Boundary absorption/impedance term	0

Variables

Name	Expression	Unit	Description	Selection
n.g_ne	-kbp*ne	1/(m ² ·s)	Boundary flux/source	Boundary 30

2.4.5 Dirichlet Boundary Condition 1



Dirichlet Boundary Condition 1

SELECTION

Geometric entity level	Boundary
Selection	Boundaries 16–17, 22, 24

EQUATIONS

$$\begin{aligned} nh &= r \\ g_{\text{reaction}} &= -\mu \end{aligned}$$

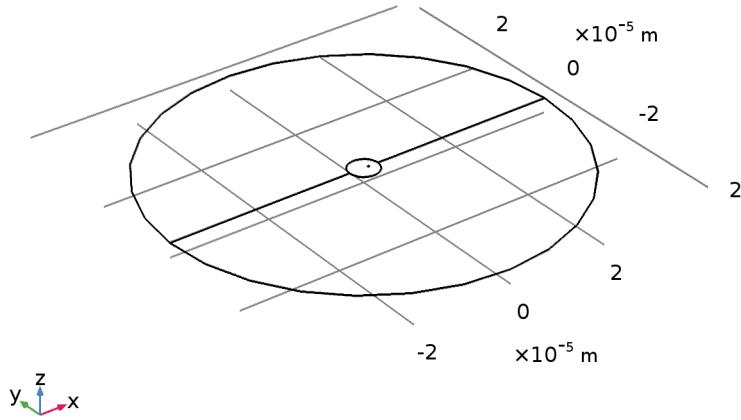
SETTINGS

Description	Value
Value on boundary	0
Prescribed value of ne	On
Apply reaction terms on	Individual dependent variables
Use weak constraints	Off
Constraint method	Elemental

Shape functions

Constraint	Constraint force	Shape function	Selection
-ne	-test(ne)	Lagrange (Quadratic)	Boundaries 16–17, 22, 24

2.5 MESH 1



Mesh 1

2.5.1 Size (size)

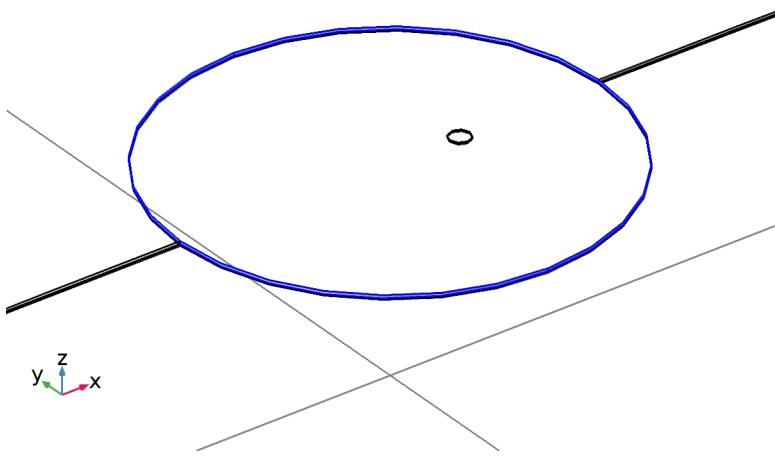
SETTINGS

Description	Value
Maximum element size	2.4E-5
Minimum element size	4.32E-6
Curvature factor	0.9
Resolution of narrow regions	0.2
Maximum element growth rate	1.85
Predefined size	Extra coarse

2.5.2 Mapped 1 (map1)

SELECTION

Geometric entity level	Boundary
Selection	Boundaries 16–17, 22, 24

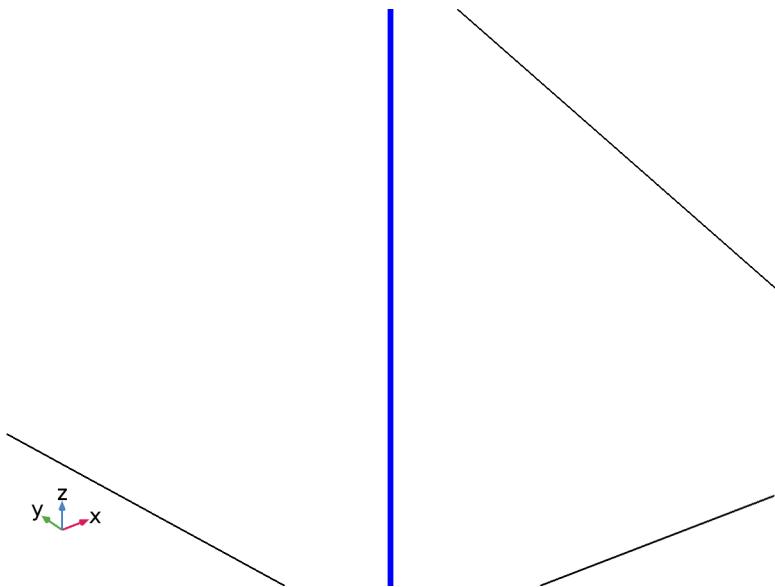


Mapped 1

Distribution 1 (dis1)

SELECTION

Geometric entity level	Edge
Selection	Edge 54



Distribution 1

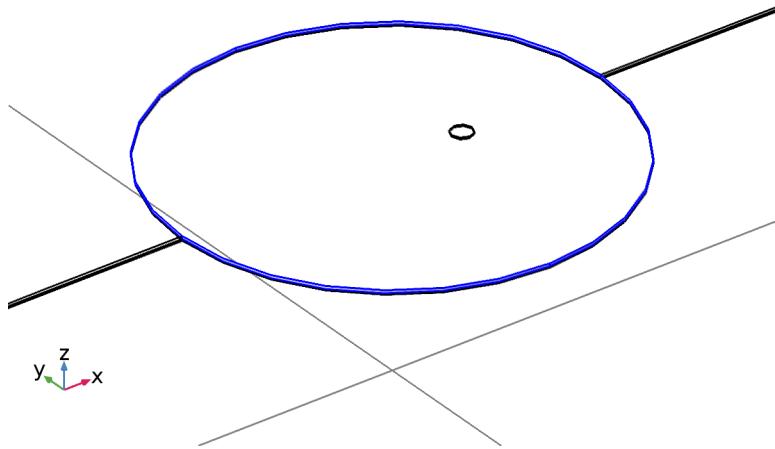
SETTINGS

Description	Value
Number of elements	round((ws - wh)/zRes)

Size 1 (size1)

SELECTION

Geometric entity level	Boundary
Selection	Boundaries 16–17, 22, 24



Size 1

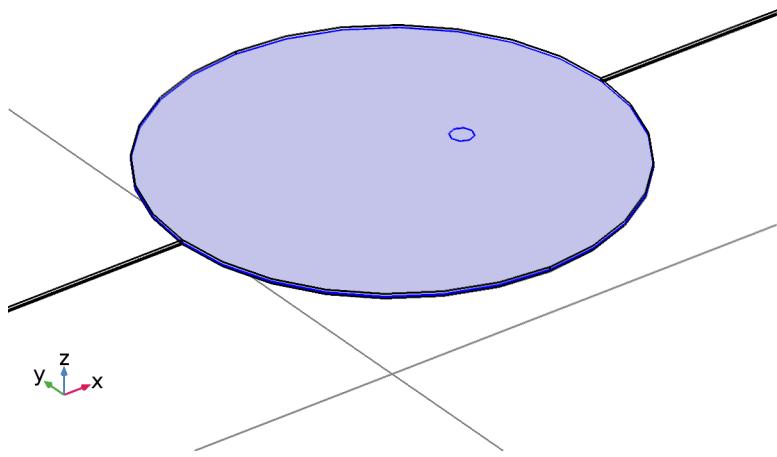
SETTINGS

Description	Value
Maximum element size	$rh/10$
Minimum element size	1.44E-6
Minimum element size	Off
Curvature factor	0.6
Curvature factor	Off
Resolution of narrow regions	0.5
Resolution of narrow regions	Off
Maximum element growth rate	1.5
Maximum element growth rate	Off
Custom element size	Custom

2.5.3 Free Triangular 1 (ftri1)

SELECTION

Geometric entity level	Boundary
Selection	Boundaries 18, 30

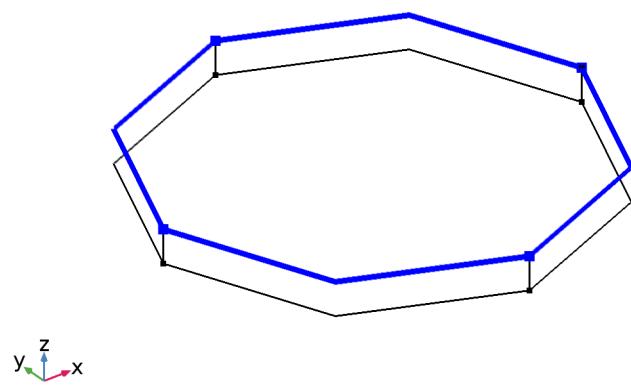


Free Triangular 1

Pipet Size (size3)

SELECTION

Geometric entity level	Edge
Selection	Edges 43–44, 47, 50



Pipet Size

SETTINGS

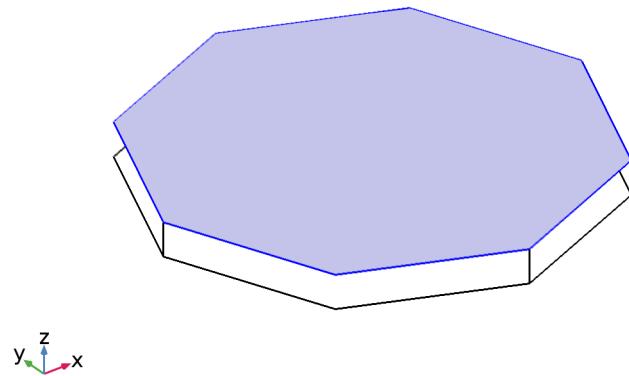
Description	Value
Maximum element size	rcoll/30
Minimum element size	1.44E-6

Description	Value
Minimum element size	Off
Curvature factor	0.6
Curvature factor	Off
Resolution of narrow regions	0.5
Resolution of narrow regions	Off
Maximum element growth rate	1.5
Maximum element growth rate	Off
Custom element size	Custom

Size 1 (size1)

SELECTION

Geometric entity level	Boundary
Name	Pipet Contact
Selection	Boundary 30



Size 1

SETTINGS

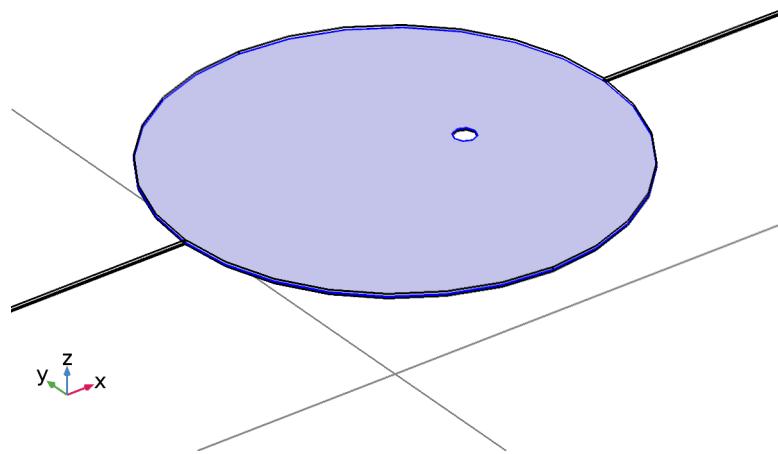
Description	Value
Maximum element size	rcoll/10
Minimum element size	1.44E-6
Minimum element size	Off
Curvature factor	0.6
Curvature factor	Off
Resolution of narrow regions	0.5
Resolution of narrow regions	Off

Description	Value
Maximum element growth rate	1.5
Maximum element growth rate	Off
Custom element size	Custom

Size 2 (size2)

SELECTION

Geometric entity level	Boundary
Selection	Boundary 18



Size 2

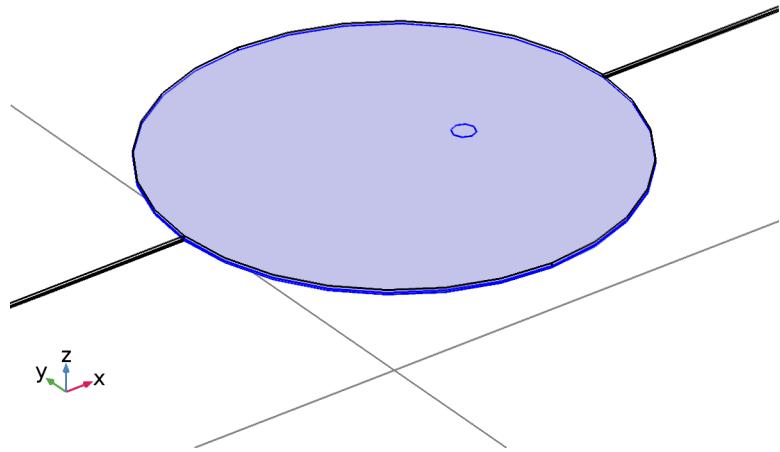
SETTINGS

Description	Value
Maximum element size	rh/10
Minimum element size	1.44E-6
Minimum element size	Off
Curvature factor	0.6
Curvature factor	Off
Resolution of narrow regions	0.5
Resolution of narrow regions	Off
Maximum element growth rate	1.5
Maximum element growth rate	Off
Custom element size	Custom

2.5.4 Swept 1 (swe1)

SELECTION

Geometric entity level	Domain
Selection	Domains 5–6

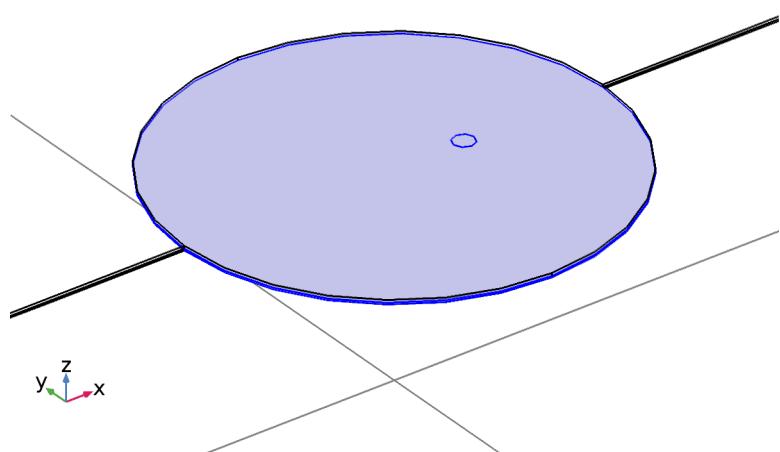


Swept 1

Distribution 1 (dis1)

SELECTION

Geometric entity level	Domain
Selection	Domains 5–6



Distribution 1

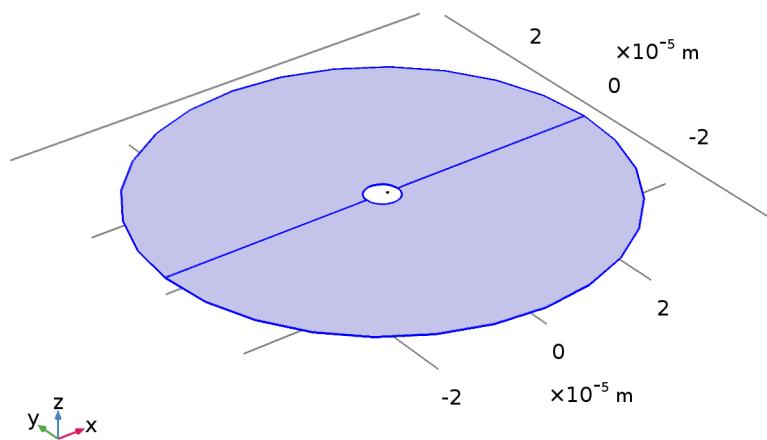
SETTINGS

Description	Value
Number of elements	round(wh/zRes)

2.5.5 Swept 2 (swe2)

SELECTION

Geometric entity level	Domain
Selection	Domains 1–4

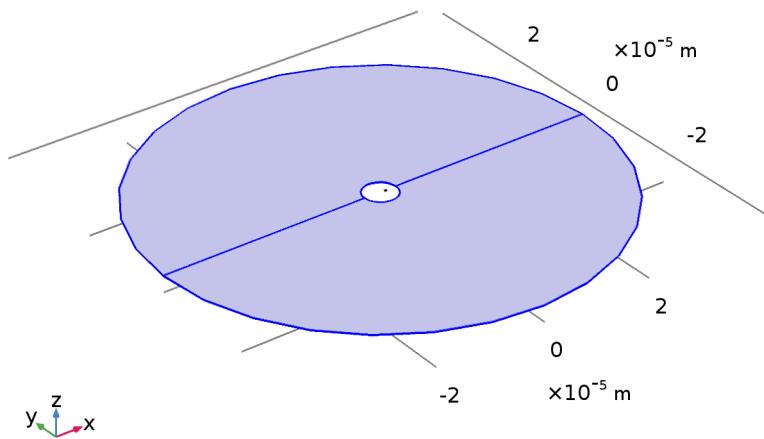


Swept 2

Distribution 1 (dis1)

SELECTION

Geometric entity level	Domain
Selection	Domains 1–4



Distribution 1

SETTINGS

Description	Value
Distribution properties	Predefined distribution type
Number of elements	10
Element ratio	50
Distribution method	Geometric sequence

3 Study 1

COMPUTATION INFORMATION

Computation time	57 min 25 s
CPU	Intel(R) Xeon(R) CPU E3-1270 v5 @ 3.60GHz, 4 cores
Operating system	Windows 7

3.1 PARAMETRIC SWEEP

Parameter name	Parameter value list	Parameter unit
wh	range(24,-2,2)	nm
xcoll	range(xyres,xyres,3*xyres)	

STUDY SETTINGS

Description	Value
Sweep type	All combinations
Parameter name	{wh, xcoll}
Parameter value list	{range(24, -2, 2), range(xyres, xyres, 3*xyres)}
Unit	{nm, }

3.2 STATIONARY

STUDY SETTINGS

Description	Value
Include geometric nonlinearity	Off

PHYSICS AND VARIABLES SELECTION

Physics interface	Discretization
Potential Distribution (E)	physics
Carrier Transport (n)	physics

MESH SELECTION

Geometry	Mesh
Geometry 1 (geom1)	mesh1

STUDY EXTENSIONS

Description	Value
Auxiliary sweep	On
Sweep type	All combinations
Parameter value list	2.07e-5

3.3 SOLVER CONFIGURATIONS

3.3.1 Solution 1

Compile Equations: Stationary (st1)

STUDY AND STEP

Description	Value
Use study	Study 1
Use study step	Stationary

Dependent Variables 1 (v1)

GENERAL

Description	Value
Defined by study step	Stationary

INITIAL VALUE CALCULATION CONSTANTS

Description	Value
Parameter initial value list	2.07e-5[cm/s]

Dependent variable E (comp1.E) (comp1_E)

GENERAL

Description	Value
Field components	comp1.E

Dependent variable ne (comp1.ne) (comp1_ne)

GENERAL

Description	Value
Field components	comp1.ne

Stationary Solver 1 (s1)

GENERAL

Description	Value
Defined by study step	Stationary

RESULTS WHILE SOLVING

Description	Value
Probes	None

Parametric 1 (p1)

GENERAL

Description	Value
Defined by study step	Stationary
Sweep type	All combinations
Parameter value list	2.07e-5

Segregated 1 (se1)

Segregated Step 1 (ss1)

GENERAL

Description	Value
Variables	Dependent variable E (comp1.E)
Linear solver	Direct

Segregated Step 2 (ss2)

GENERAL

Description	Value
Variables	Dependent variable ne (comp1.ne)
Linear solver	Direct

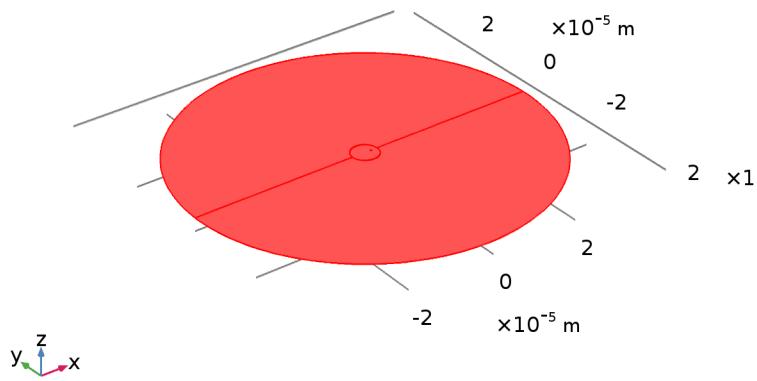
4 Results

4.1 DATA SETS

4.1.1 Study 1/Solution 1

SOLUTION

Description	Value
Solution	Solution 1
Component	Save Point Geometry 1

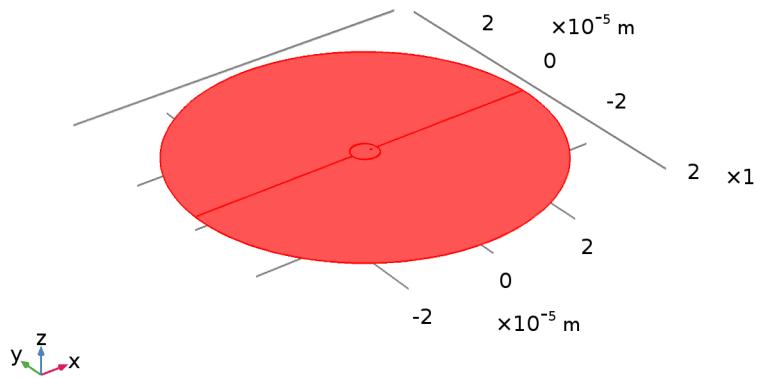


Data set: Study 1/Solution 1

4.1.2 Probe Solution 2

SOLUTION

Description	Value
Solution	Solution 1
Component	Save Point Geometry 1



Data set: Probe Solution 2

4.2 DERIVED VALUES

4.2.1 Global Variable Probe 1

DATA

Description	Value
Data set	Probe Solution 2

EXPRESSIONS

Expression	Unit	Description
e_const*intop1(kbp*ne)	A	Current

OUTPUT

Evaluated in	Accumulated Probe Table 3
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4.3 TABLES

4.3.1 Probe Table 2

PROBE TABLE 2

kbp (cm/s)	Current (A)
2.0700E-5	-2.3709E-14

4.3.2 Evaluation 3D

Interactive 3D values

EVALUATION 3D

x	y	z	Value
-2.0088E-7	2.1317E-16	5.2829E-8	-3.4645E32

4.3.3 Evaluation 2D

Interactive 2D values

EVALUATION 2D

x	y	Value
-2.0620E-7	2.5125E-8	0.0000
-2.0273E-7	-2.1659E-8	0.0000
-2.2699E-7	-7.8840E-8	-3.1374E-279
-2.0966E-7	-1.0310E-7	-2.8019E-280

4.3.4 Accumulated Probe Table 3

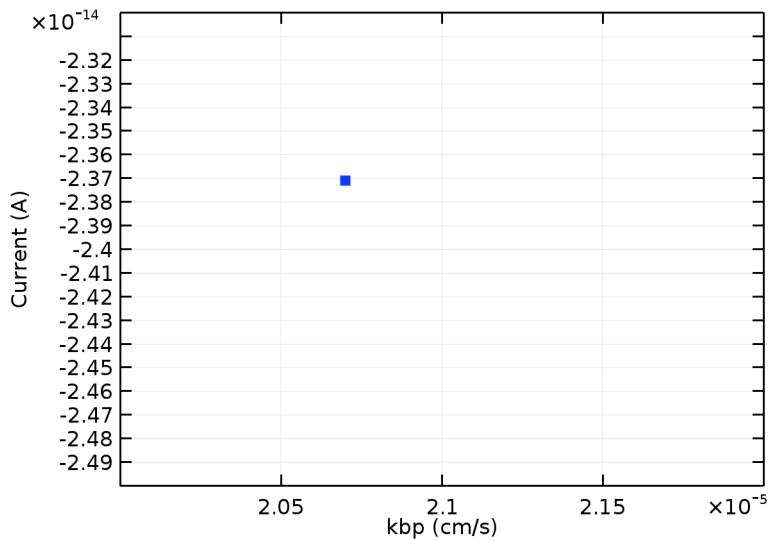
ACCUMULATED PROBE TABLE 3

wh	xcoll	kbp	Current, Global Variable Probe 1
2.4000E-8	5.0000E-7	2.0700E-7	3.0002E-12
2.4000E-8	1.0000E-6	2.0700E-7	2.5452E-12
2.4000E-8	1.5000E-6	2.0700E-7	2.1863E-12

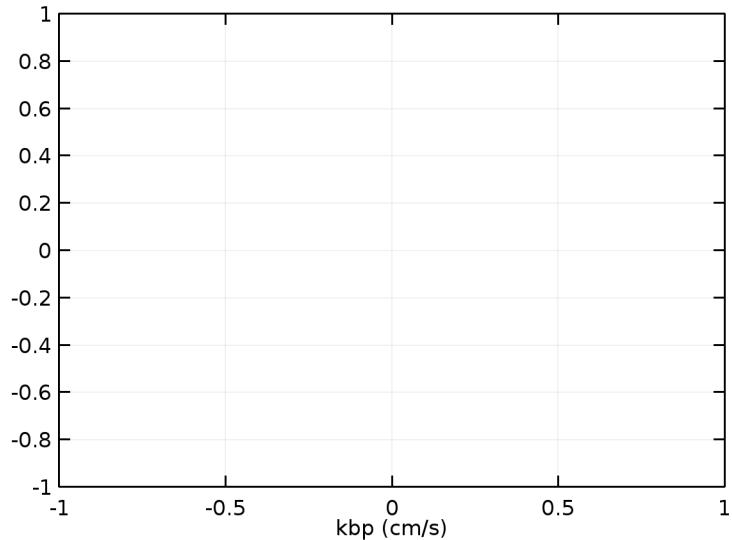
wh	xcoll	kbp	Current, Global Variable Probe 1
2.2000E-8	5.0000E-7	2.0700E-7	2.7933E-12
2.2000E-8	1.0000E-6	2.0700E-7	2.3209E-12
2.2000E-8	1.5000E-6	2.0700E-7	1.9769E-12
2.0000E-8	5.0000E-7	2.0700E-7	2.5402E-12
2.0000E-8	1.0000E-6	2.0700E-7	2.0568E-12
2.0000E-8	1.5000E-6	2.0700E-7	1.7339E-12
1.8000E-8	5.0000E-7	2.0700E-7	2.2317E-12
1.8000E-8	1.0000E-6	2.0700E-7	1.7513E-12
1.8000E-8	1.5000E-6	2.0700E-7	1.4579E-12
1.6000E-8	5.0000E-7	2.0700E-7	1.8647E-12
1.6000E-8	1.0000E-6	2.0700E-7	1.4113E-12
1.6000E-8	1.5000E-6	2.0700E-7	1.1569E-12
1.4000E-8	5.0000E-7	2.0700E-7	1.4494E-12
1.4000E-8	1.0000E-6	2.0700E-7	1.0545E-12
1.4000E-8	1.5000E-6	2.0700E-7	8.4797E-13
1.2000E-8	5.0000E-7	2.0700E-7	1.0163E-12
1.2000E-8	1.0000E-6	2.0700E-7	7.1006E-13
1.2000E-8	1.5000E-6	2.0700E-7	5.5710E-13
1.0000E-8	5.0000E-7	2.0700E-7	6.1461E-13
1.0000E-8	1.0000E-6	2.0700E-7	4.1271E-13
1.0000E-8	1.5000E-6	2.0700E-7	3.1456E-13
8.0000E-9	5.0000E-7	2.0700E-7	2.9940E-13
8.0000E-9	1.0000E-6	2.0700E-7	1.9436E-13
8.0000E-9	1.5000E-6	2.0700E-7	1.4538E-13
6.0000E-9	5.0000E-7	2.0700E-7	1.0633E-13
6.0000E-9	1.0000E-6	2.0700E-7	6.8857E-14
6.0000E-9	1.5000E-6	2.0700E-7	5.3170E-14
4.0000E-9	5.0000E-7	2.0700E-7	2.1728E-14
4.0000E-9	1.0000E-6	2.0700E-7	1.5691E-14
4.0000E-9	1.5000E-6	2.0700E-7	1.3418E-14
2.0000E-9	5.0000E-7	2.0700E-7	-7.2782E-14
2.0000E-9	1.0000E-6	2.0700E-7	-4.5214E-15
2.0000E-9	1.5000E-6	2.0700E-7	-2.3709E-14

4.4 PLOT GROUPS

4.4.1 Probe Plot Group 3

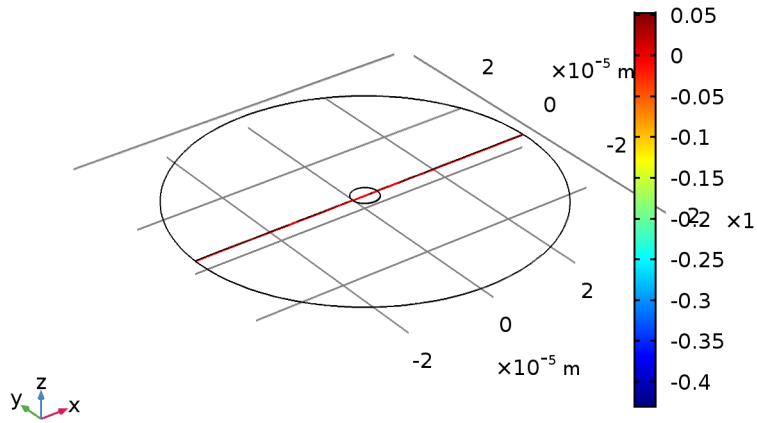


4.4.2 Probe Plot Group 9



4.4.3 3D Plot Group 10

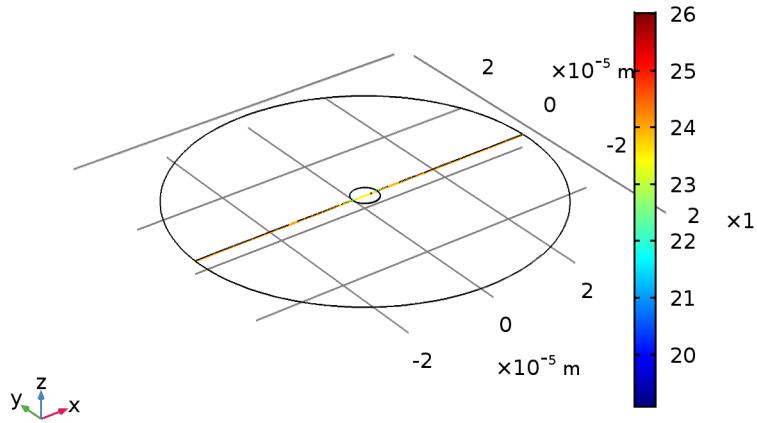
$kbp(1)=2.07E-5 \text{ cm/s}$ Slice: Dependent variable E (V)



$kbp(1)=2.07E-5 \text{ cm/s}$ Slice: Dependent variable E (V)

4.4.4 3D Plot Group 11

$kbp(1)=2.07E-5 \text{ cm/s}$ Slice: log10(nh)



$kbp(1)=2.07E-5 \text{ cm/s}$ Slice: log10(ne)