

TITLE : EM SIMULATION PROJECT

SUBJECT:ELECTRONICS MATERIALS – BEE201L

SLOT : C2+TC2 – TT415

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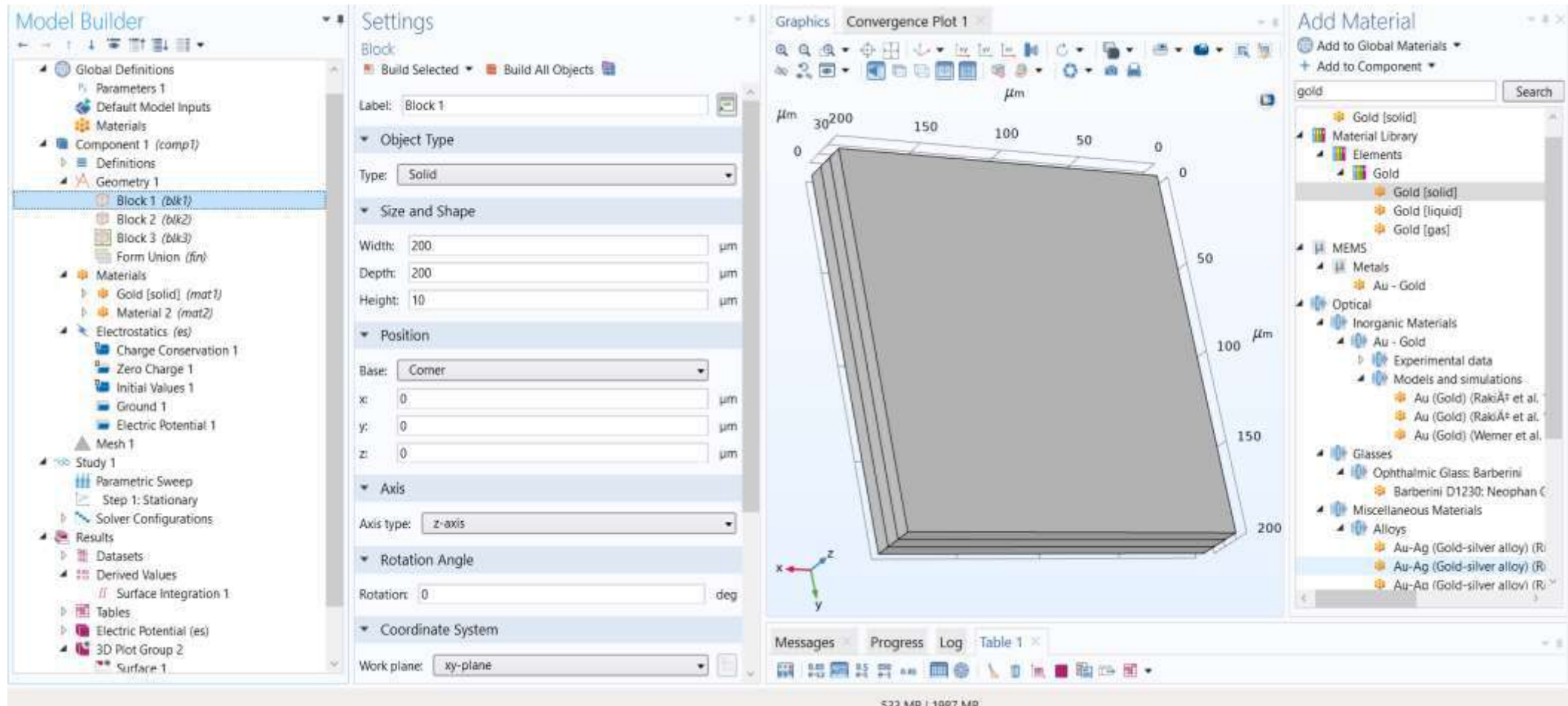
BRANCH: BTECH

COURSE: ELECTRONICS AND ELECTRICAL ENGINEERING

REGISTRATION NO:24BEE0241

FACULTY : SIR UMA SATHYAKAM P

GEOMETRY 1 :



GOLD [SOLID](mat1):

The screenshot displays the COMSOL Multiphysics interface with the following components:

- Model Builder:** Shows a hierarchy starting with 'Untitled.mph (root)', followed by 'Global Definitions', 'Component 1 (comp1)', 'Definitions', 'Geometry 1', and 'Materials'. The 'Materials' node is selected, showing 'Gold [solid] (mat1)' and 'Material 2 (mat2)'. Below it, 'Electrostatics (es)' is expanded, showing 'Charge Conservation 1', 'Zero Charge 1', and 'Initial Values 1'. 'Mesh 1' and 'Study 1' (Step 1: Stationary) are also visible.
- Settings:** The 'Material' tab is active, showing 'Label: Gold [solid]'. Under 'Geometric Entity Selection', 'Geometric entity level' is set to 'Domain' and 'Selection' is 'Manual'. A list shows domain 1 selected. The 'Material Contents' table is expanded, showing properties for Gold [solid].
- Graphics:** A 3D isometric view of a gold structure, which is a rectangular block with a smaller rectangular cutout on top. Dimensions are labeled in micrometers (μm): 200, 150, 100, 50, 0, 30, 20, 0, 150, 100, 50, 0.
- Add Material:** A panel on the right showing a search for 'gold'. It lists 'Recent Materials' (Gold [solid], Gold [liquid], Gold [gas]) and 'Material Library' (Elements, Gold). Under 'Gold', it lists 'Gold [solid]', 'Gold [liquid]', and 'Gold [gas]'. Under 'MEMS', it lists 'Metals' (Au - Gold) and 'Optical' (Inorganic Materials, Au - Gold). Under 'Au - Gold', it lists 'Experimental data' (Au (Gold) (Johnson et al.), Au (Gold) (McPeak et al.), Au (Gold) (Babar and), Au (Gold) (Lemarchar), Au (Gold) (Lemarchar), Au (Gold) (Lemarchar), Au (Gold) (Lemarchar)).
- Messages:** A log window at the bottom showing the following messages:
 - [Jan 23, 2025 2:29 PM] Finalized geometry is empty.
 - [Jan 23, 2025 2:33 PM] Formed union of 3 solid objects.
 - [Jan 23, 2025 2:33 PM] Finalized geometry has 3 domains, 16 boundaries, 28 edges, and 16 vertices.

MATERIAL 2 (mat 2) :

The screenshot displays the COMSOL Multiphysics interface with the following components:

- Model Builder:** Shows the project hierarchy. Under 'Component 1 (comp1)', 'Materials' is expanded, and 'Material 2 (mat2)' is selected.
- Settings:** The 'Material' tab is active for 'Material 2'.
 - Geometric Entity Selection:** 'Geometric entity level' is set to 'Domain' and 'Selection' is 'Manual'. A small thumbnail of the domain is shown.
 - Material Contents:** A table lists the material properties.
- Graphics:** A 3D isometric view of a rectangular block with a layered structure. The top layer is grey, and the bottom layer is blue. Dimensions are labeled in μm : the top layer is 200 μm wide and 50 μm high, and the bottom layer is 200 μm wide and 30 μm high. A coordinate system (x, y, z) is shown at the bottom left.
- Add Material:** A search bar contains 'gold'. The 'Material Library' is expanded, showing 'Gold' under 'Elements'.
- Messages:** A log of messages at the bottom right.

Property	Variable	Value	Unit	Prop
Relative permittivity	epsilo...	a	1	Basic

Messages:

- [Jan 23, 2025 2:29 PM] Finalized geometry is empty.
- [Jan 23, 2025 2:33 PM] Formed union of 3 solid objects.
- [Jan 23, 2025 2:33 PM] Finalized geometry has 3 domains, 16 boundaries, 28 edges, and 16 vertices.

ELECTROSTATICS (es) :

The screenshot displays the COMSOL Multiphysics interface with the following components:

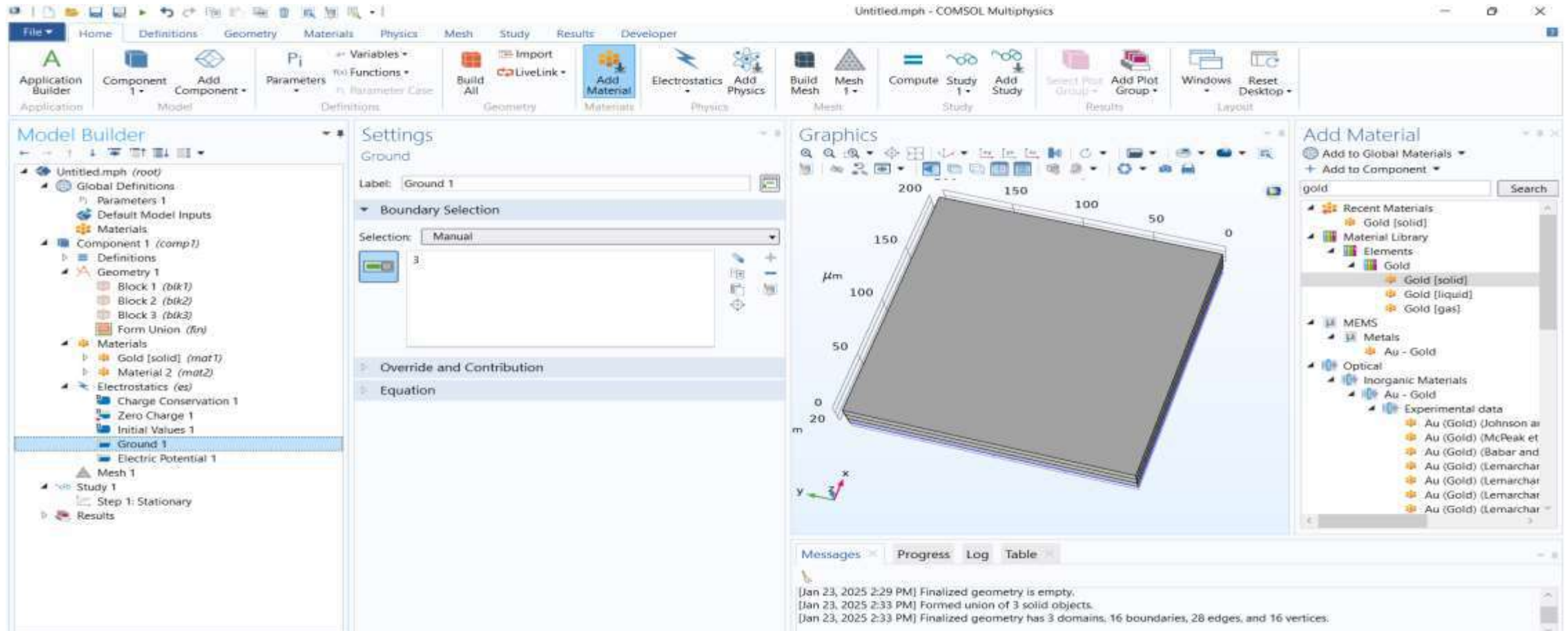
- Model Builder:** Shows the hierarchy of the model. The 'Electrostatics (es)' node is selected under 'Materials'. Other nodes include 'Global Definitions', 'Parameters 1', 'Default Model Inputs', 'Materials', 'Component 1 (comp1)', 'Definitions', 'Geometry 1', 'Block 1 (blk1)', 'Block 2 (blk2)', 'Block 3 (blk3)', 'Form Union (fin)', 'Materials', 'Gold [solid] (mat1)', 'Material 2 (mat2)', 'Charge Conservation 1', 'Zero Charge 1', 'Initial Values 1', 'Mesh 1', 'Study 1', 'Step 1: Stationary', and 'Results'.
- Settings:** The 'Electrostatics' settings are shown. The 'Label' is 'Electrostatics' and the 'Name' is 'es'. The 'Domain Selection' is set to 'All domains'. The 'Equation' section is expanded, showing 'Manual Terminal Sweep Settings' with 'Reference impedance' set to '50[ohm]' and 'Use manual terminal sweep' checked. The 'Discretization' and 'Dependent Variables' sections are also visible.
- Graphics:** A 3D visualization of the geometry is shown. The dimensions are 200 μm by 200 μm by 50 μm . The axes are labeled x, y, and z.
- Add Material:** The 'Add Material' dialog is open, showing a search for 'gold'. The 'Material Library' is expanded, showing 'Elements' and 'Gold'. The 'Gold [solid]' material is selected.
- Messages:** The 'Messages' tab is active, showing the following log entries:
 - [Jan 23, 2025 2:29 PM] Finalized geometry is empty.
 - [Jan 23, 2025 2:33 PM] Formed union of 3 solid objects.
 - [Jan 23, 2025 2:33 PM] Finalized geometry has 3 domains, 16 boundaries, 28 edges, and 16 vertices.

ELECTRI POTENTIAL 1 :

The screenshot displays the COMSOL Multiphysics software interface, configured for an "Electric Potential" study. The interface is divided into several panels:

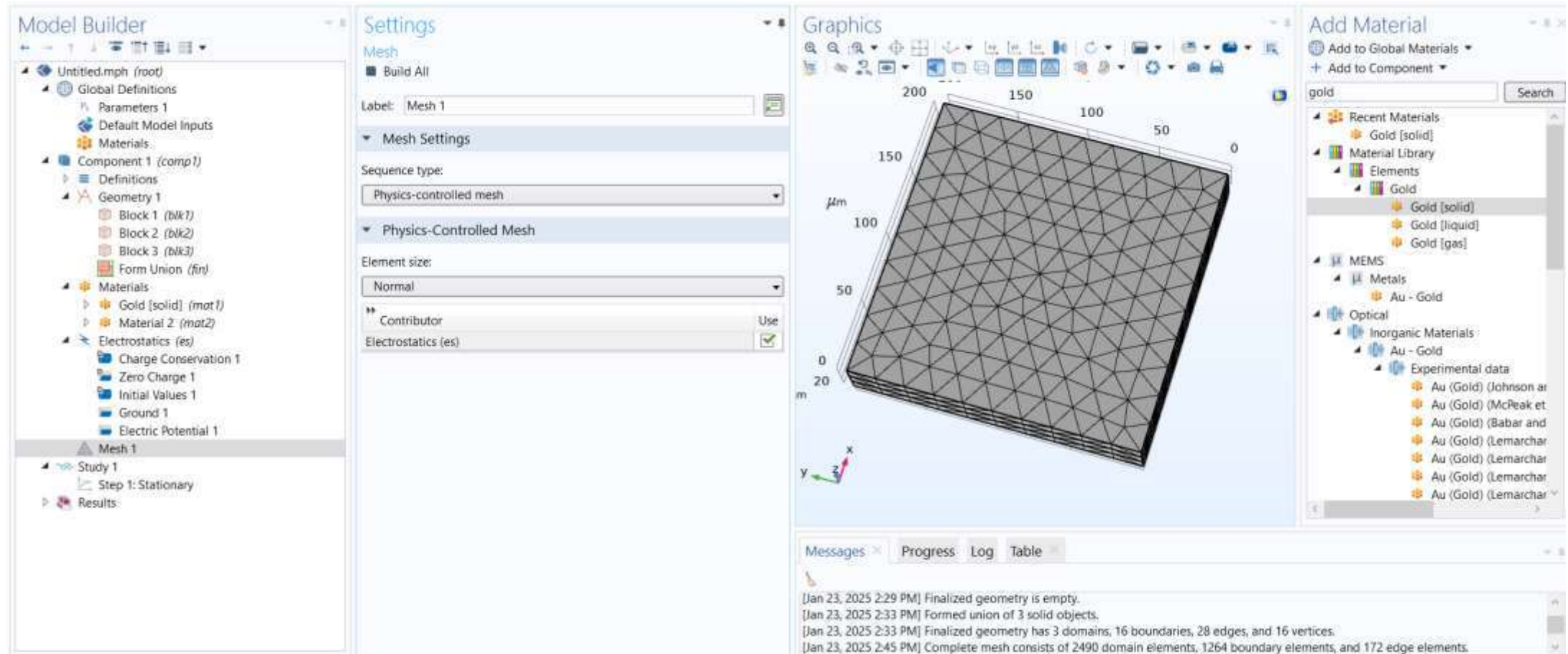
- Model Builder:** Shows the hierarchical structure of the model. The "Electric Potential 1" component is selected under the "Electrostatics (es)" physics interface. The geometry consists of three blocks (blk1, blk2, blk3) and a form union (fn).
- Settings:** The "Electric Potential" settings are visible. The "Boundary Selection" is set to "Manual", and the "Electric potential" is defined as V_0 with a value of 5 V.
- Graphics:** A 3D visualization of the geometry is shown. The dimensions are labeled in μm : 200, 150, 100, 50, 0, 150, 100, 50, 0, 20. The coordinate system (x, y, z) is indicated.
- Add Material:** The "Add Material" panel is open, showing a search for "gold". The "Material Library" is expanded, and "Gold [solid]" is selected.
- Messages:** The bottom panel displays the following messages:
 - [Jan 23, 2025 2:29 PM] Finalized geometry is empty.
 - [Jan 23, 2025 2:33 PM] Formed union of 3 solid objects.
 - [Jan 23, 2025 2:33 PM] Finalized geometry has 3 domains, 16 boundaries, 28 edges, and 16 vertices.

GROUND 1:



MESH 1:

ELEMENT SIZE : NORMAL



ELEMENT SIZE : FINER

Model Builder

- Untitled.mph (root)
 - Global Definitions
 - Parameters 1
 - Default Model Inputs
 - Materials
 - Component 1 (comp1)
 - Definitions
 - Geometry 1
 - Block 1 (blk1)
 - Block 2 (blk2)
 - Block 3 (blk3)
 - Form Union (fin)
 - Materials
 - Gold [solid] (mat1)
 - Material 2 (mat2)
 - Electrostatics (es)
 - Charge Conservation 1
 - Zero Charge 1
 - Initial Values 1
 - Ground 1
 - Electric Potential 1
 - Mesh 1
 - Study 1
 - Step 1: Stationary
 - Results

Settings

Mesh

Build All

Label: Mesh 1

Mesh Settings

Sequence type: Physics-controlled mesh

Physics-Controlled Mesh

Element size: Finer

Contributor: Electrostatics (es) Use

Graphics

200 150 100 50 0

150 100 50 0

μm

0 20

m

Add Material

Add to Global Materials + Add to Component

gold Search

Recent Materials

- Gold [solid]

Material Library

- Elements
 - Gold
 - Gold [solid]
 - Gold [liquid]
 - Gold [gas]

MEMS

- Metals
 - Au - Gold

Optical

- Inorganic Materials
 - Au - Gold
 - Experimental data
 - Au (Gold) (Johnson et al.)
 - Au (Gold) (McPeak et al.)
 - Au (Gold) (Babar and ...)
 - Au (Gold) (Lemarchar ...)
 - Au (Gold) (Lemarchar ...)
 - Au (Gold) (Lemarchar ...)
 - Au (Gold) (Lemarchar ...)

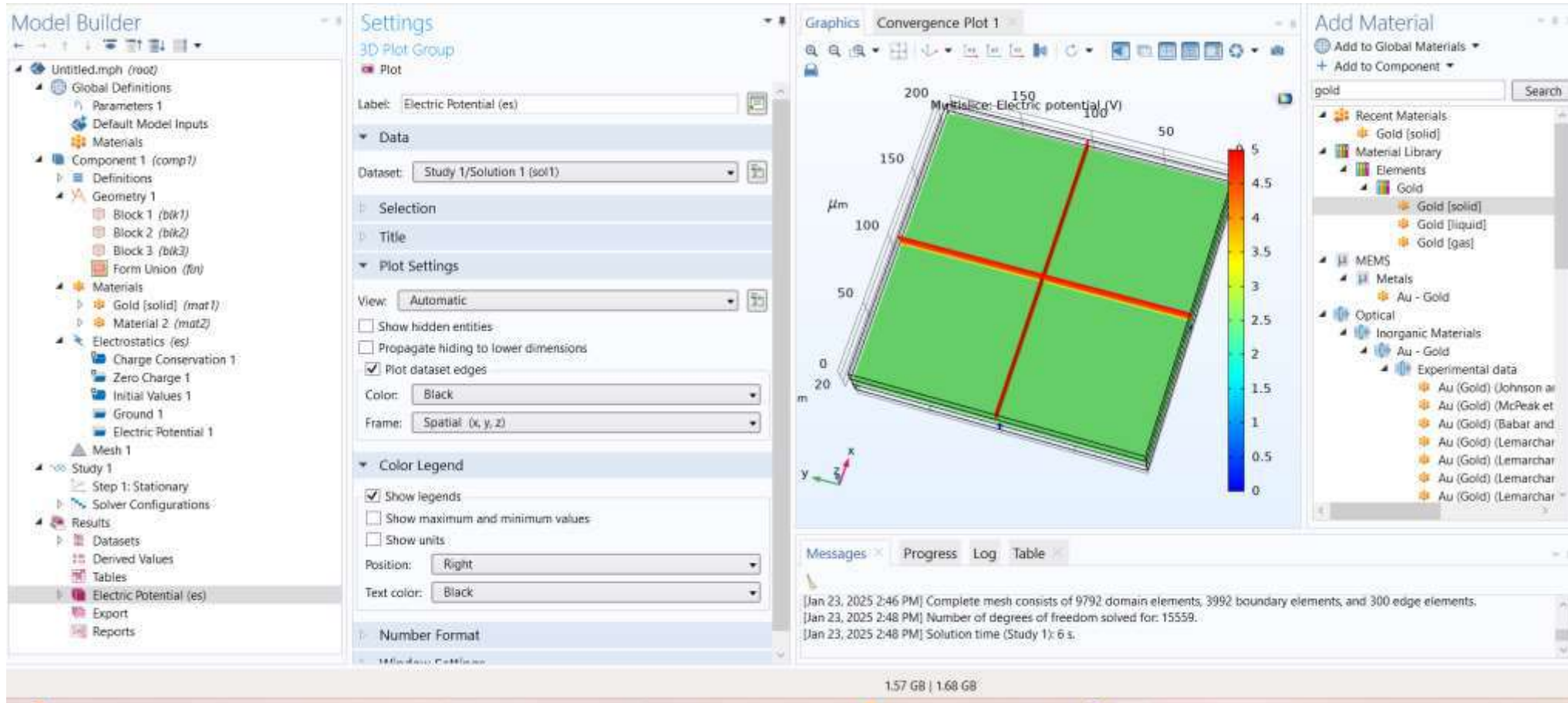
Messages Progress Log Table

[Jan 23, 2025 2:33 PM] Finalized geometry has 3 domains, 16 boundaries, 28 edges, and 16 vertices.

[Jan 23, 2025 2:45 PM] Complete mesh consists of 2490 domain elements, 1264 boundary elements, and 172 edge elements.

[Jan 23, 2025 2:46 PM] Complete mesh consists of 9792 domain elements, 3992 boundary elements, and 300 edge elements.

ELECTRI POTENTIAL(es) :



3D PLOT GROUP 2 :

The screenshot displays the COMSOL Multiphysics software interface, specifically the **Model Builder** and **Settings** panes for **3D Plot Group 2**.

Model Builder (Left Pane):

- Global Definitions
 - Parameters 1
 - Default Model Inputs
 - Materials
- Component 1 (comp1)
 - Definitions
 - Geometry 1
 - Block 1 (blk1)
 - Block 2 (blk2)
 - Block 3 (blk3)
 - Form Union (fin)
 - Materials
 - Gold [solid] (mat1)
 - Material 2 (mat2)
 - Electrostatics (es)
 - Charge Conservation 1
 - Zero Charge 1
 - Initial Values 1
 - Ground 1
 - Electric Potential 1
 - Mesh 1
 - Study 1
 - Step 1: Stationary
 - Solver Configurations
 - Results
 - Datasets
 - Derived Values
 - Tables
 - Electric Potential (es)
 - 3D Plot Group 2** (selected)
 - Export
 - Reports

Settings (Middle Pane):

3D Plot Group

Plot

Label: 3D Plot Group 2

Data

Dataset: Study 1/Solution 1 (sol1)

Selection

Title

Plot Settings

View: Automatic

☐ Show hidden entities

☐ Propagate hiding to lower dimensions

☒ Plot dataset edges

Color: Black

Frame: Material (X, Y, Z)

Color Legend

☒ Show legends

☐ Show maximum and minimum values

☐ Show units

Position: Right

Text color: Black

Number Format

Graphics (Right Pane):

Convergence Plot 1

The 3D plot shows a rectangular domain with dimensions 50, 100, 150, 200, 150, 100, 50, and 0 μm . The axes are labeled x, y, and z.

Add Material (Far Right Pane):

gold

Search

Recent Materials

- Gold [solid]

Material Library

- Elements
 - Gold
 - Gold [solid]
 - Gold [liquid]
 - Gold [gas]

MEMS

- Metals
 - Au - Gold

Optical

- Inorganic Materials
 - Au - Gold
 - Experimental data
 - Au (Gold) (Johnson et al.)
 - Au (Gold) (McPeak et al.)
 - Au (Gold) (Babar and Lemarchar)
 - Au (Gold) (Lemarchar)
 - Au (Gold) (Lemarchar)
 - Au (Gold) (Lemarchar)
 - Au (Gold) (Lemarchar)

Messages (Bottom Pane):

Progress Log Table

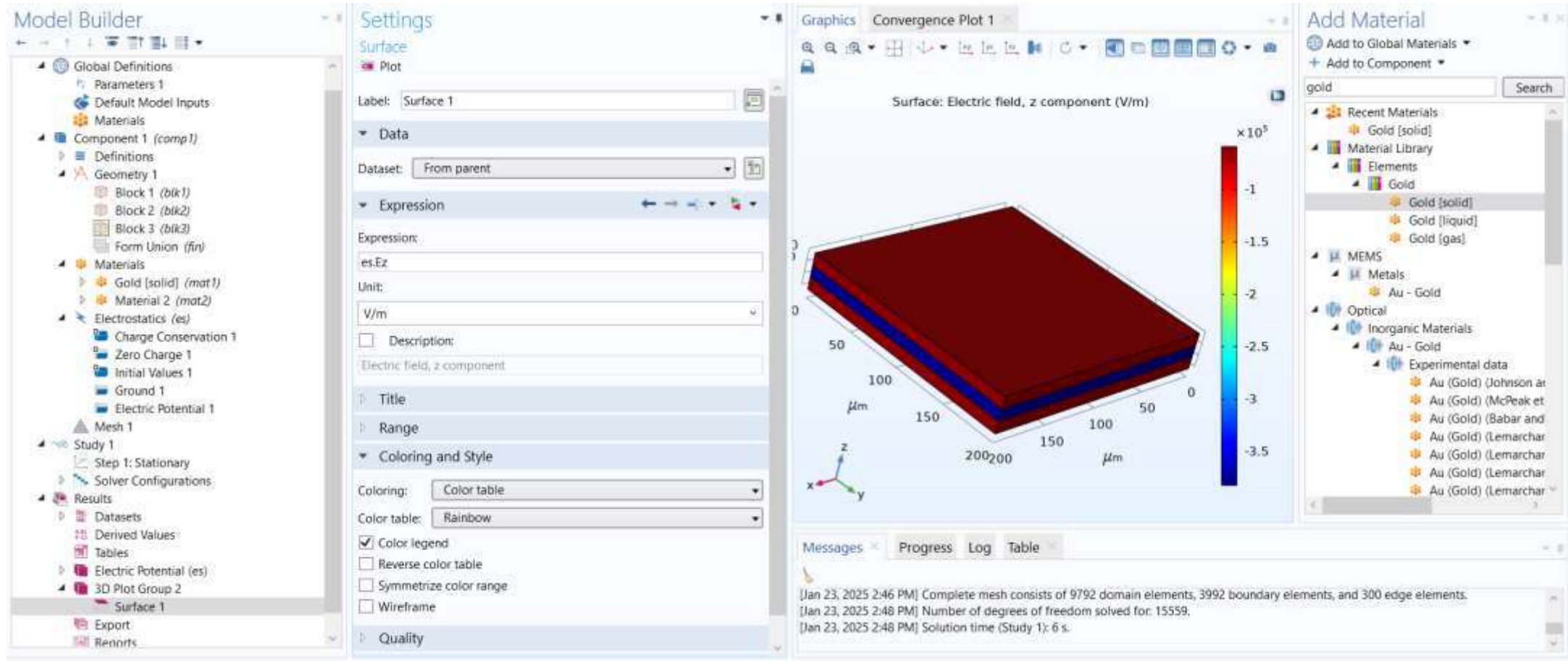
[Jan 23, 2025 2:46 PM] Complete mesh consists of 9792 domain elements, 3992 boundary elements, and 300 edge elements.

[Jan 23, 2025 2:48 PM] Number of degrees of freedom solved for: 15559.

[Jan 23, 2025 2:48 PM] Solution time (Study 1): 6 s.

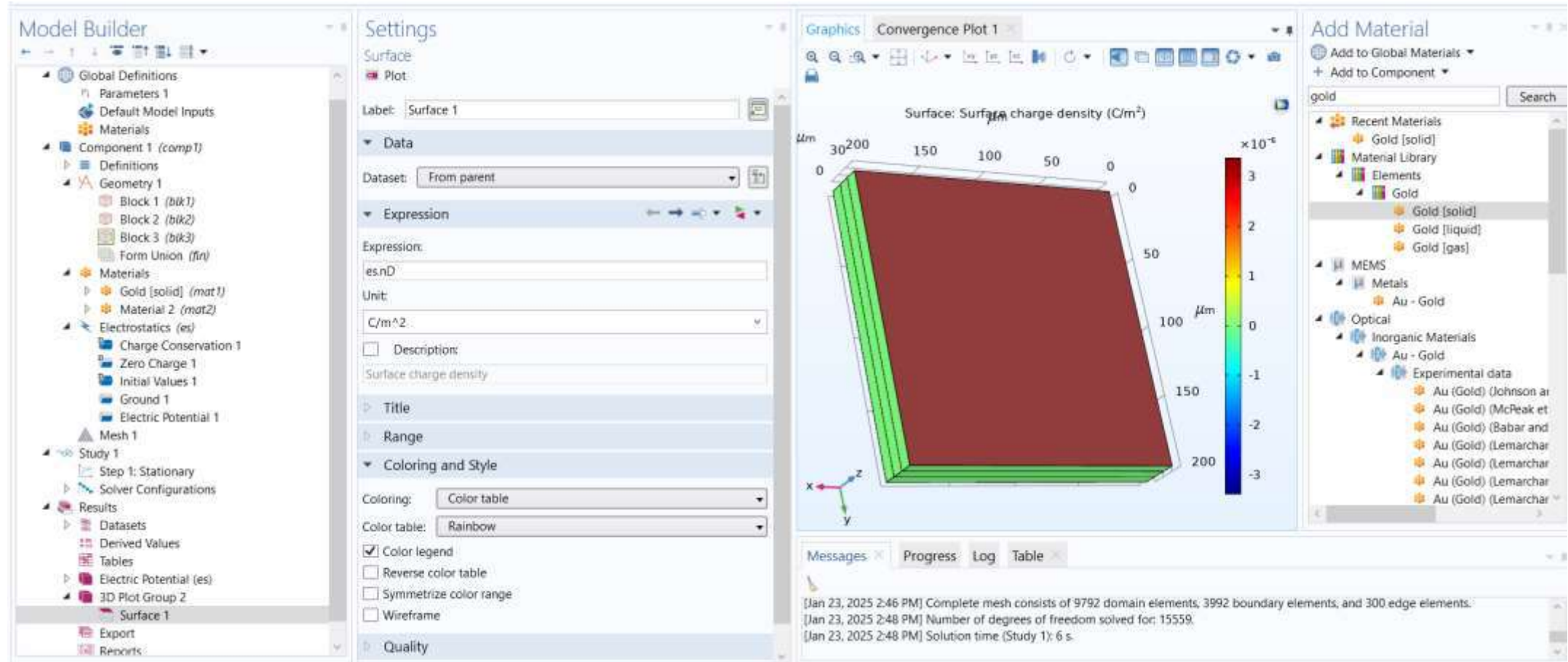
SURFACE 1 : ELECTRIC FIELD ,z COMPONENT

UNIT : V/m



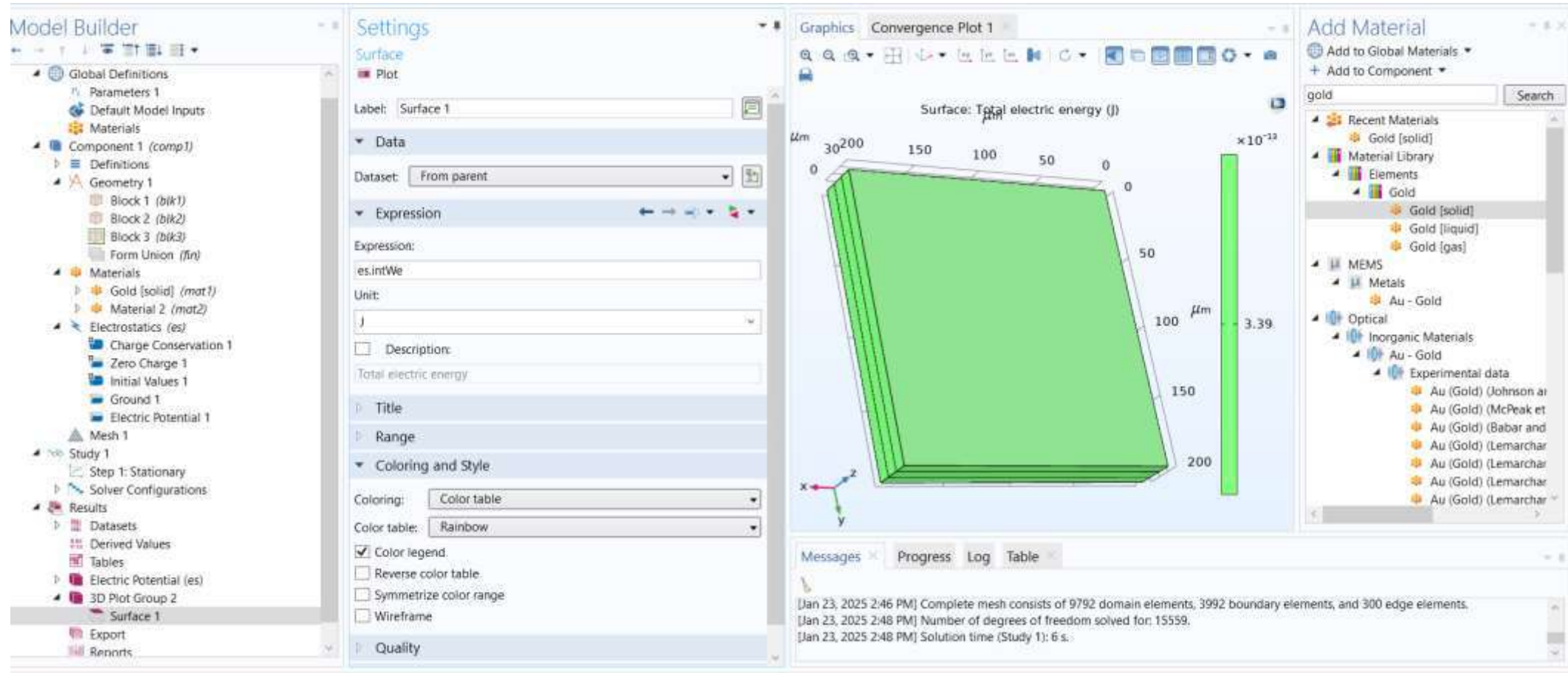
SURFACE 1 : SURFACE CHARGE DENSITY

UNIT : C/m²

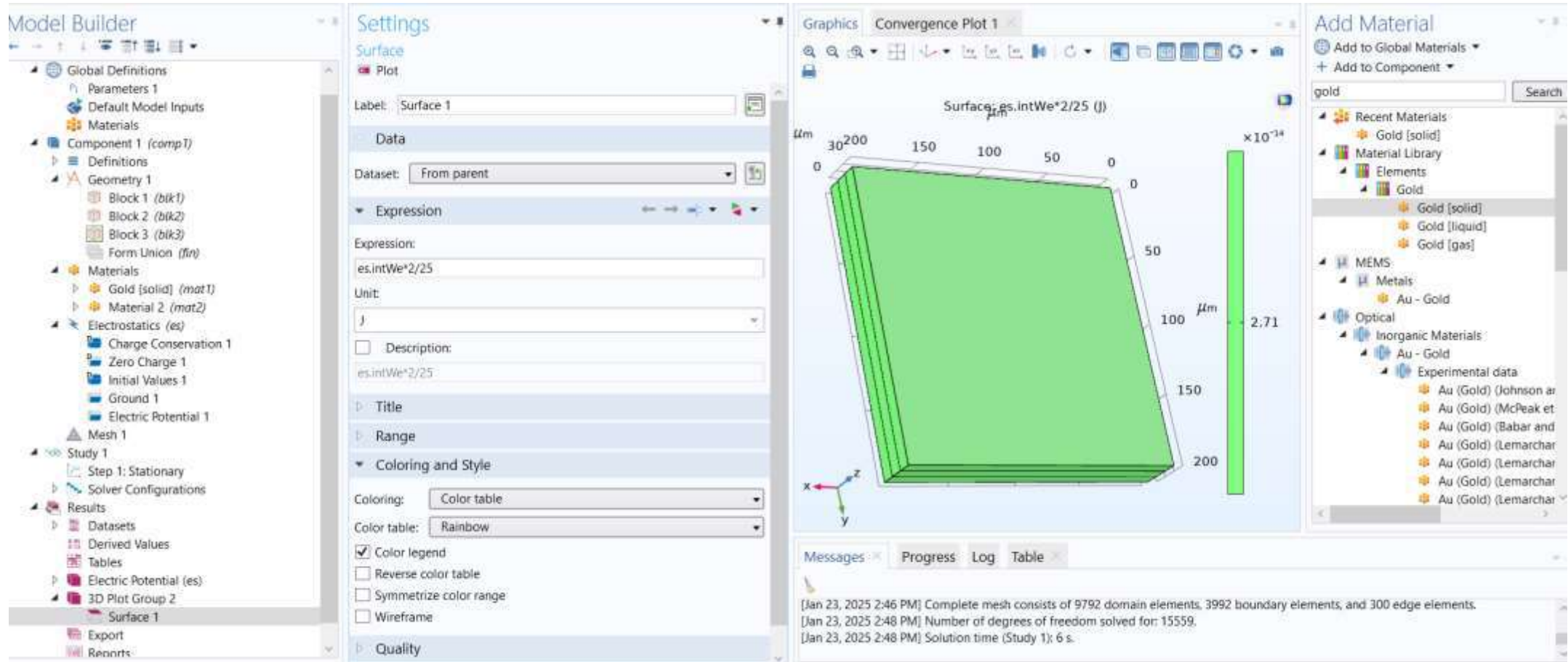


SURFACE 1 : TOTAL ELECTRIC ENERGY

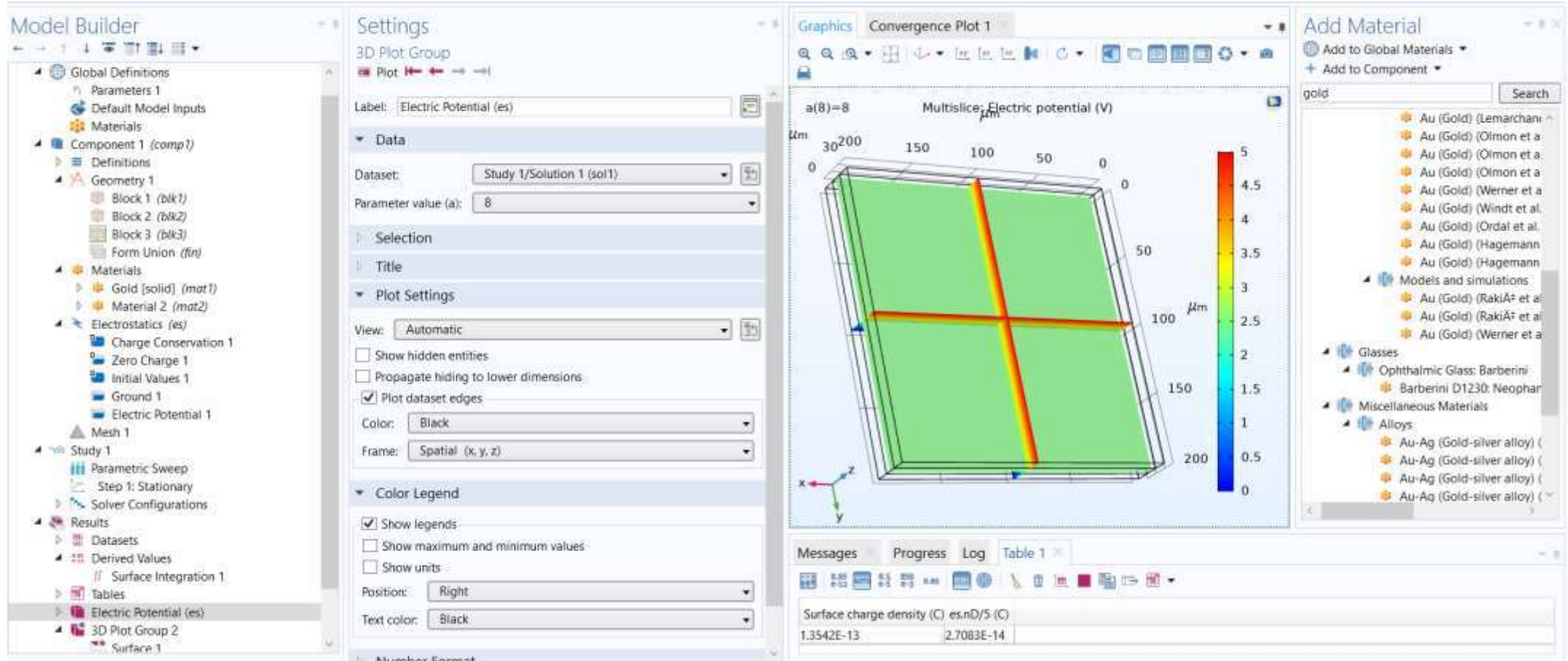
UNIT : J



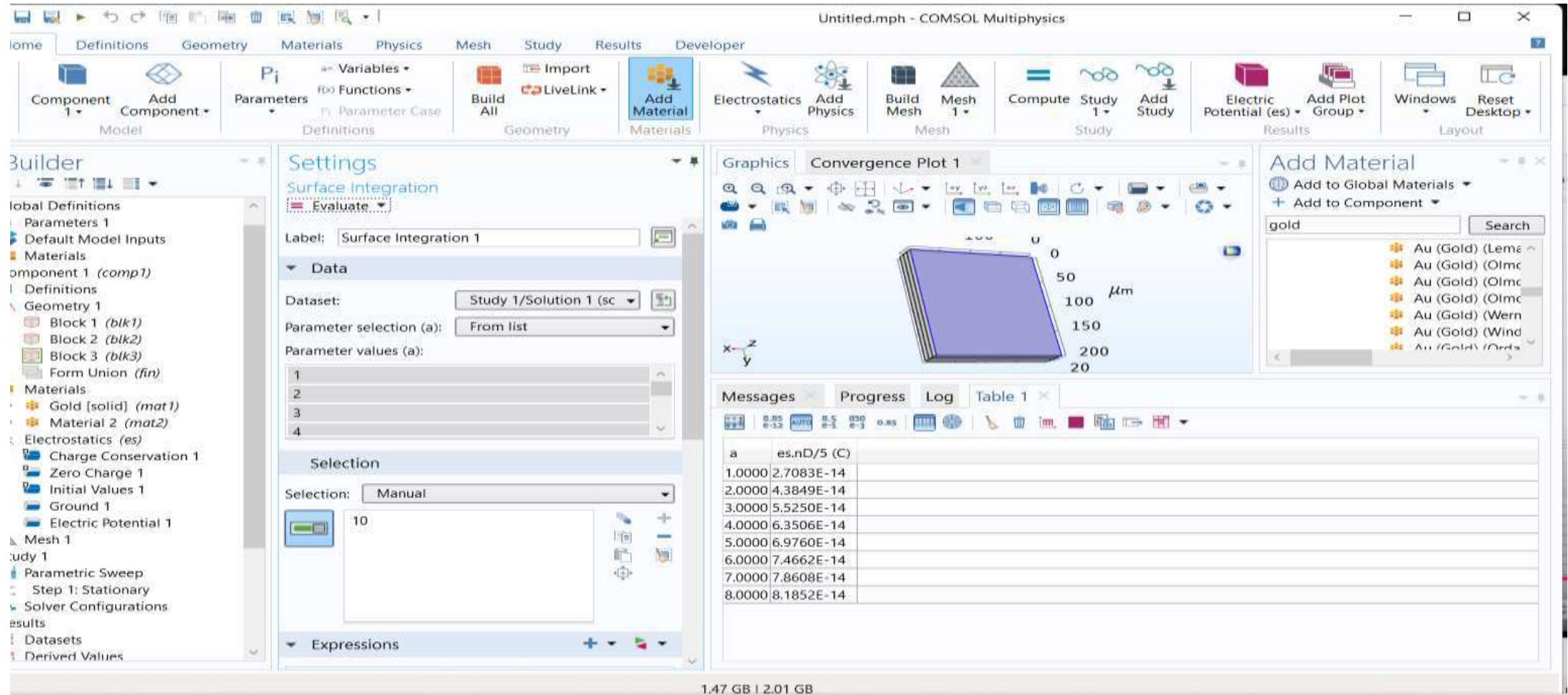
SURFACE 1 : $es.intWE*2/25(J)$



MULTISLICE : ELECTRIC POTENTIAL(V)



PARAMETER VALUES (a):



Builder

- Global Definitions
 - Parameters 1
- Default Model Inputs
- Materials
 - Component 1 (comp1)
 - Definitions
 - Geometry 1
 - Block 1 (blk1)
 - Block 2 (blk2)
 - Block 3 (blk3)
 - Form Union (fn)
 - Materials
 - Gold [solid] (mat1)
 - Material 2 (mat2)
 - Electrostatics (es)
 - Charge Conservation 1
 - Zero Charge 1
 - Initial Values 1
 - Ground 1
 - Electric Potential 1
 - Mesh 1
- Study 1
 - Parametric Sweep
 - Step 1: Stationary
 - Solver Configurations
- Results
 - Datasets
 - Derived Values

Settings

Surface Integration

Label: Surface Integration 1

Data

Dataset: Study 1/Solution 1 (sc)

Parameter selection (a): From list

Parameter values (a):

1
2
3
4

Selection

Selection: Manual

10

Expressions

Graphics

Convergence Plot 1

Messages

Progress

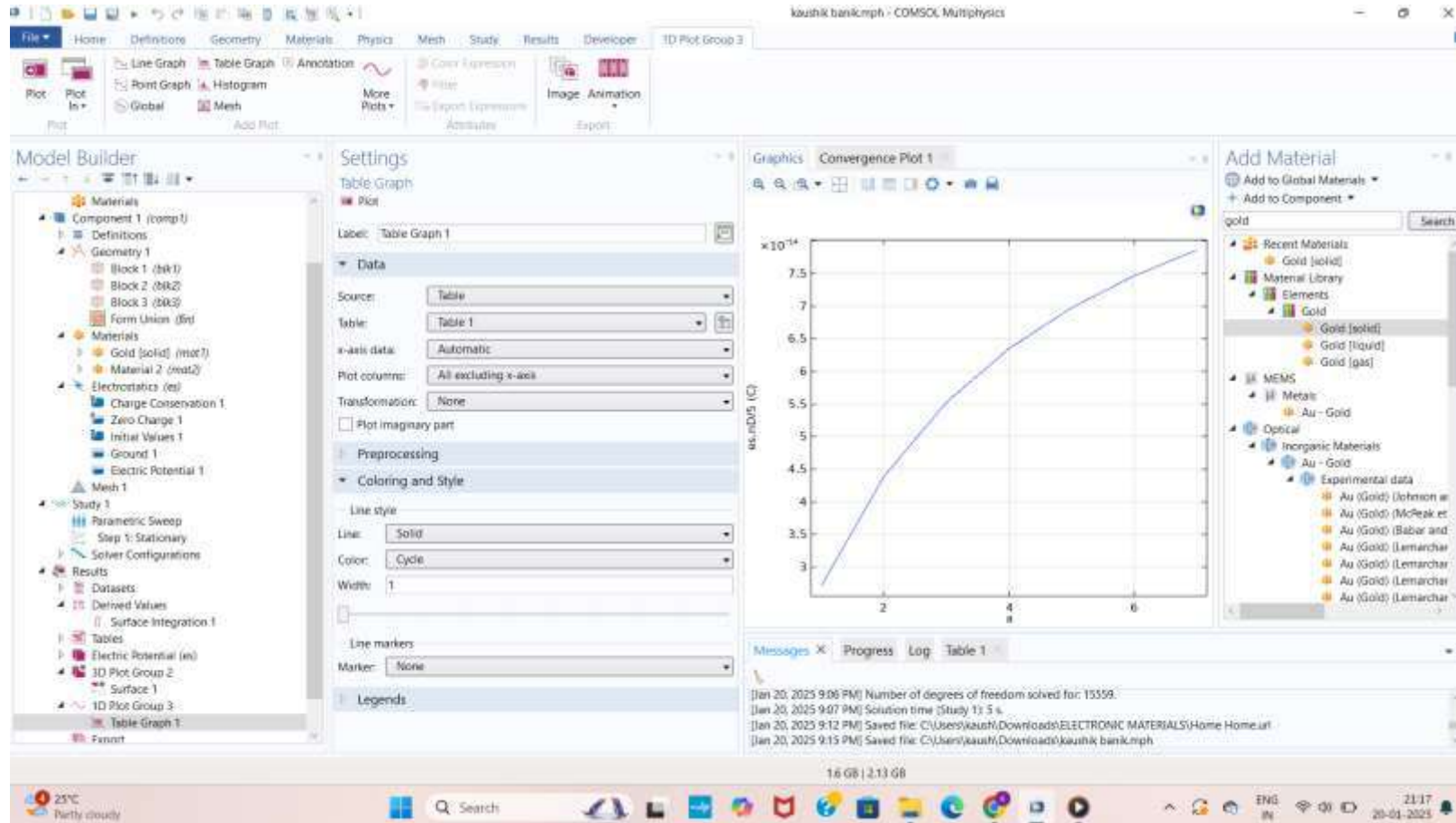
Log

Table 1

a	es.nD/5 (C)
1.0000	2.7083E-14
2.0000	4.3849E-14
3.0000	5.5250E-14
4.0000	6.3506E-14
5.0000	6.9760E-14
6.0000	7.4662E-14
7.0000	7.8608E-14
8.0000	8.1852E-14

1.47 GB | 2.01 GB

GRAPH :



THANK YOU