

Tellurium

# General information

- Atomic number 52
- Chalcogen group
- Metalloid
- Density 6.24 g/cm<sup>3</sup>
- Melting point 722.66 K
- Boiling point 1261 K
- Price 70 €/ kg

The image shows a periodic table of elements. A callout box for Hydrogen (H) is positioned above the table, displaying its atomic number (1), symbol (H), name (Hydrogen), and chemical group block (Nonmetal). The element Tellurium (Te) is circled in the table, located in the 5th period and 16th group. The table includes element symbols, names, and group classifications. A dropdown menu at the top right is set to 'Chemical Group Block'.

1 H Hydrogen Nonmetal																	2 He Helium Noble Gas
3 Li Lithium Alkali Metal	4 Be Beryllium Alkaline Earth											5 B Boron Metalloid	6 C Carbon Nonmetal	7 N Nitrogen Nonmetal	8 O Oxygen Nonmetal	9 F Fluorine Halogen	10 Ne Neon Noble Gas
11 Na Sodium Alkali Metal	12 Mg Magnesium Alkaline Earth											13 Al Aluminum Post-transition	14 Si Silicon Metalloid	15 P Phosphorus Nonmetal	16 S Sulfur Nonmetal	17 Cl Chlorine Halogen	18 Ar Argon Noble Gas
19 K Potassium Alkali Metal	20 Ca Calcium Alkaline Earth	21 Sc Scandium Transition Meta	22 Ti Titanium Transition Meta	23 V Vanadium Transition Meta	24 Cr Chromium Transition Meta	25 Mn Manganese Transition Meta	26 Fe Iron Transition Meta	27 Co Cobalt Transition Meta	28 Ni Nickel Transition Meta	29 Cu Copper Transition Meta	30 Zn Zinc Transition Meta	31 Ga Gallium Post-transition	32 Ge Germanium Metalloid	33 As Arsenic Metalloid	34 Se Selenium Nonmetal	35 Br Bromine Halogen	36 Kr Krypton Noble Gas
37 Rb Rubidium Alkali Metal	38 Sr Strontium Alkaline Earth	39 Y Yttrium Transition Meta	40 Zr Zirconium Transition Meta	41 Nb Niobium Transition Meta	42 Mo Molybdenum Transition Meta	43 Tc Technetium Transition Meta	44 Ru Ruthenium Transition Meta	45 Rh Rhodium Transition Meta	46 Pd Palladium Transition Meta	47 Ag Silver Transition Meta	48 Cd Cadmium Transition Meta	49 In Indium Post-transition	50 Sn Tin Post-transition	51 Sb Antimony Metalloid	52 Te Tellurium Metalloid	53 I Iodine Halogen	54 Xe Xenon Noble Gas
55 Cs Cesium Alkali Metal	56 Ba Barium Alkaline Earth	*	72 Hf Hafnium Transition Meta	73 Ta Tantalum Transition Meta	74 W Tungsten Transition Meta	75 Re Rhenium Transition Meta	76 Os Osmium Transition Meta	77 Ir Iridium Transition Meta	78 Pt Platinum Transition Meta	79 Au Gold Transition Meta	80 Hg Mercury Transition Meta	81 Tl Thallium Post-transition	82 Pb Lead Post-transition	83 Bi Bismuth Post-transition	84 Po Polonium Metalloid	85 At Astatine Halogen	86 Rn Radon Noble Gas
87 Fr Francium Alkali Metal	88 Ra Radium Alkaline Earth	**	104 Rf Rutherfordium Transition Meta	105 Db Dubnium Transition Meta	106 Sg Seaborgium Transition Meta	107 Bh Bohrium Transition Meta	108 Hs Hassium Transition Meta	109 Mt Meitnerium Transition Meta	110 Ds Darmstadtium Transition Meta	111 Rg Roentgenium Transition Meta	112 Cn Copernicium Transition Meta	113 Nh Nihonium Post-transition	114 Fl Flerovium Post-transition	115 Mc Moscovium Post-transition	116 Lv Livermorium Post-transition	117 Ts Tennessine Halogen	118 Og Oganesson Noble Gas

Department of health and human services. (2016, October). *Periodic Table of Elements*. National Library of Medicine. Retrieved October 11, 2022, from <https://pubchem.ncbi.nlm.nih.gov/periodic-table/#view=table>

# Abundance and Production

- Yearly production 400-650 tons
- Abundance in earth's crust 1-5 ppb
- No mining for purely Te
- Ca 90 % of production from copper anode slime, from copper electrorefining
- Anode slime 0.5 - 5 weight-% Te

# Discovery

- Te discovered in a Romanian goldmine at end of the 18<sup>th</sup> century
- Discovered by Franz-joseph muller von reichenstein, Austrian
  - Found it in the compound  $\text{AuTe}_2$
  - Thought first it was bismuth sulfide
  - Doped it 'metallum problematicum'
- Named by Martin Heinrich Klaproth
  - latin 'Tellus' = earth
  - Historically there was thought to be a connection between the 7 planets and the up to then 7 discovered metals (Mercury)
  - Also named Uranium after freshly discovered uranus
  - Klaproth tried to continue this pattern by naming it after earth



Wikipedia contributors. (2022, September 25). *Tellurium*. Wikipedia. Retrieved October 11, 2022, from <https://en.wikipedia.org/wiki/Tellurium>

# Chemistry

												DISPLAY PROPERTY/TREND						
												Chemical Group Block						
1	2											13	14	15	16	17	18	
1 H Hydrogen Nonmetal												5 B Boron Metalloid	6 C Carbon Nonmetal	7 N Nitrogen Nonmetal	8 O Oxygen Nonmetal	9 F Fluorine Halogen	10 Ne Neon Noble Gas	
2	3	4											13	14	15	16	17	18
3 Li Lithium Alkali Metal	4 Be Beryllium Alkaline Earth Metal											14 Si Silicon Metalloid	15 P Phosphorus Nonmetal	16 S Sulfur Nonmetal	17 Cl Chlorine Halogen	18 Ar Argon Noble Gas		
3	11	12											13	14	15	16	17	18
11 Na Sodium Alkali Metal	12 Mg Magnesium Alkaline Earth Metal											13 Al Aluminum Post-transition	14 Si Silicon Metalloid	15 P Phosphorus Nonmetal	16 S Sulfur Nonmetal	17 Cl Chlorine Halogen	18 Ar Argon Noble Gas	
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
19 K Potassium Alkali Metal	20 Ca Calcium Alkaline Earth Metal	21 Sc Scandium Transition Metal	22 Ti Titanium Transition Metal	23 V Vanadium Transition Metal	24 Cr Chromium Transition Metal	25 Mn Manganese Transition Metal	26 Fe Iron Transition Metal	27 Co Cobalt Transition Metal	28 Ni Nickel Transition Metal	29 Cu Copper Transition Metal	30 Zn Zinc Transition Metal	31 Ga Gallium Post-transition	32 Ge Germanium Metalloid	33 As Arsenic Metalloid	34 Se Selenium Nonmetal	35 Br Bromine Halogen	36 Kr Krypton Noble Gas	
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
37 Rb Rubidium Alkali Metal	38 Sr Strontium Alkaline Earth Metal	39 Y Yttrium Transition Metal	40 Zr Zirconium Transition Metal	41 Nb Niobium Transition Metal	42 Mo Molybdenum Transition Metal	43 Tc Technetium Transition Metal	44 Ru Ruthenium Transition Metal	45 Rh Rhodium Transition Metal	46 Pd Palladium Transition Metal	47 Ag Silver Transition Metal	48 Cd Cadmium Transition Metal	49 In Indium Post-transition	50 Sn Tin Post-transition	51 Sb Antimony Metalloid	52 Te Tellurium Metalloid	53 I Iodine Halogen	54 Xe Xenon Noble Gas	
6	55	56	*	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
55 Cs Cesium Alkali Metal	56 Ba Barium Alkaline Earth Metal	*	72 Hf Hafnium Transition Metal	73 Ta Tantalum Transition Metal	74 W Tungsten Transition Metal	75 Re Rhenium Transition Metal	76 Os Osmium Transition Metal	77 Ir Iridium Transition Metal	78 Pt Platinum Transition Metal	79 Au Gold Transition Metal	80 Hg Mercury Transition Metal	81 Tl Thallium Post-transition	82 Pb Lead Post-transition	83 Bi Bismuth Post-transition	84 Po Polonium Metalloid	85 At Astatine Halogen	86 Rn Radon Noble Gas	
7	87	88	**	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118
87 Fr Francium Alkali Metal	88 Ra Radium Alkaline Earth Metal	**	104 Rf Rutherfordium Transition Metal	105 Db Dubnium Transition Metal	106 Sg Seaborgium Transition Metal	107 Bh Bohrium Transition Metal	108 Hs Hassium Transition Metal	109 Mt Meitnerium Transition Metal	110 Ds Darmstadtium Transition Metal	111 Rg Roentgenium Transition Metal	112 Cn Copernicium Transition Metal	113 Nh Nihonium Post-transition	114 Fl Flerovium Post-transition	115 Mc Moscovium Post-transition	116 Lv Livermorium Post-transition	117 Ts Tennessine Halogen	118 Og Oganesson Noble Gas	

1	Atomic Number
H	Symbol
Hydrogen	Name
Nonmetal	Chemical Group Block



Department of health and human services. (2016, October). *Periodic Table of Elements*. National Library of Medicine. Retrieved October 11, 2022, from <https://pubchem.ncbi.nlm.nih.gov/periodic-table/#view=tablee>

# Chemistry

- Electron configuration:  $[\text{Kr}] 4d^{10} 5s^2 5p^4$  (6 valence electrons)
- Group VI elements: More metallic with increasing atomic radius
- Metalloid: On the edge between metals and non-metals



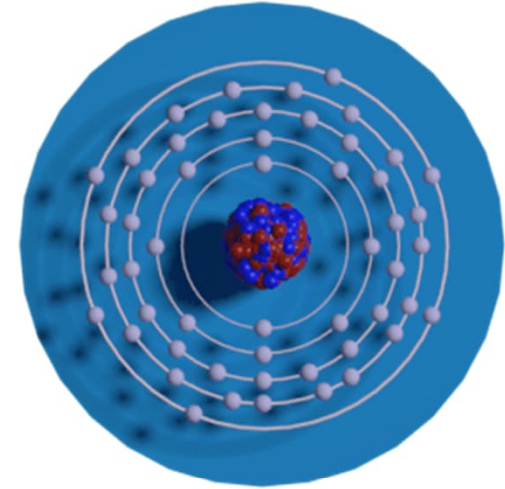
Wothers, P. (2020, January 27). *Tellurium*. Chemistry World. Retrieved October 11, 2022, from <https://www.chemistryworld.com/podcasts/tellurium/3005967.article>

Metallic	Non-metallic
Crystalline, looks like a metal	Low melting point (~450°C)
Semiconductor	Brittle, breaks easily (ceramic)

# Chemistry

- [Kr] 4d<sup>10</sup> 5s<sup>2</sup> 5p<sup>4</sup>
- Oxidation states: -2, +4, +6 (stable ones)
  - -2 : 8 valence electrons
  - +4 (Most common): Fully filled valence s-orbital
  - +6 : fully filled 4D orbital
- Atomic Radius
  - Neutral atom has a radius of 1.38 Å
  - Anion with -2 charge: 2.21 Å
  - Cation with +4 charge:
    - Coordination III: 0.66 Å
    - Coordination VI: 1.11 Å
  - Cation with +6 charge:
    - Coordination IV: 0.57 Å
    - Coordination VI: 0.7 Å

Te  
Tellurium



Atomic number  
protons / electrons

52

Neutrons  
(most common isotope)

78

Atomic weight  
(amu)

127.6

Atomic radius  
(pm)

138

[Kr] 4d<sup>10</sup> 5s<sup>2</sup> 5p<sup>4</sup>

7s  7p

6s  6p  6d

5s  5p  5d  5f

4s  4p  4d  4f

3s  3p  3d

2s  2p

1s

*Tellurium - Atomic Number - Atomic Mass - Density of Tellurium | nuclear-power.com. (2021, November 26). Nuclear Power. Retrieved October 11, 2022, from <https://www.nuclear-power.com/tellurium-atomic-number-mass-density>*

# Compounds

- Gold Telluride:  $\text{AuTe}_2$  (-I)
  - Compound in which Tellurium was discovered
- Cadmium Telluride:  $\text{CdTe}$  (-II)
  - Used for the production of thin film solar cells
  - Cheaper than conventional solar cells
  - Good conductor of electricity
- Tellurium dioxide:  $\text{TeO}_2$  (+IV)
  - Can react both as a base or an acid
  - Can form glass under certain conditions
  - Used in acousto-optic applications
    - Regulation of lasers through the interaction of light waves and sound waves
    - Crystal is strained by mechanical waves, which changes the refraction index
    - Acousto-optic modulator: Shift frequency of transmitted light using soundwaves

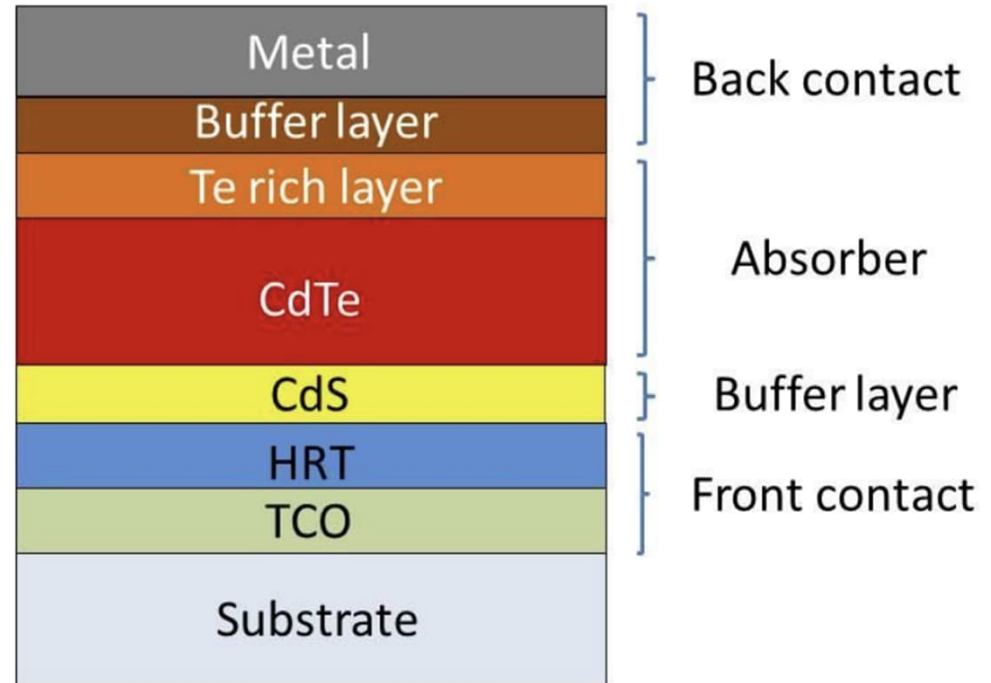


# Applications

- Electronics (CdTe)
- Thin film solar cells (CdTe)
- Metallurgy (as additive in alloys)
- Thermoelectric applications
- Oxidation catalyst
- Vulcanizing of rubber

# CdTe thin film solar cells

- First introduced in 1972
- CdTe band gap near 1.5 eV (corresponds to photon wavelength of 826 nm)
- Cell efficiency up to of 22.1 % (review from 2021)
- About 5 % of total PV production



Romeo, Alessandro, and Elisa Artegiani. "CdTe-Based Thin Film Solar Cells: Past, Present and Future." *Energies*. 14.6 (2021)

# Sources

- Department of health and human services. (2016, October). *Periodic Table of Elements*. National Library of Medicine. Retrieved October 11, 2022, from <https://pubchem.ncbi.nlm.nih.gov/periodic-table/#view=tableee>
- *Radii for All Species*. (n.d.). Retrieved October 11, 2022, from <http://abulafia.mt.ic.ac.uk/shannon/radius.php?orderby=Chargee>
- *Tellurium - Atomic Number - Atomic Mass - Density of Tellurium | nuclear-power.com*. (2021, November 26). Nuclear Power. Retrieved October 11, 2022, from <https://www.nuclear-power.com/tellurium-atomic-number-mass-density>
- Wikipedia contributors. (2022, September 25). *Tellurium*. Wikipedia. Retrieved October 11, 2022, from <https://en.wikipedia.org/wiki/Tellurium>
- Wothers, P. (2020, January 27). *Tellurium*. Chemistry World. Retrieved October 11, 2022, from <https://www.chemistryworld.com/podcasts/tellurium/3005967.art>

# Sources

- Romeo, Alessandro, and Elisa Artegiani. *"CdTe-Based Thin Film Solar Cells: Past, Present and Future."* Energies. 14.6 (2021): n. pag. Web.
- Kupi Aleksanteri. *"Tellurium cementation from copper anode slime leachate."* Bachelor's thesis (2022), Aalto University, School of Chemical Engineering.
- Yang, MM; Zhu, HY; Su, TC; Yang, Manman; Zhu, Hongyu; Yi, Wencai; Li, Shangsheng; Hu, Meihua; Hu, Qiang; Du, Baoli; Liu, Xiaobing; Su, Taichao. *"Electrical transport and thermoelectric properties of Te–Se solid solutions."* Physics letters. (2019) Vol.383(22), p. 2615-2620.
- *"Mineral Commodity Summaries 2022 – Tellurium"* Retrieved October 11, 2022, from <https://www.usgs.gov/centers/national-minerals-information-center/selenium-and-tellurium-statistics-and-information>

