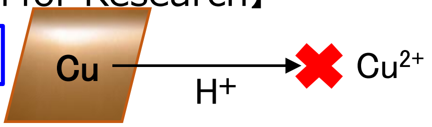
Process of dissolving copper in hydrogen peroxide solution

Miyazaki Prefectural Miyazaki Nishi High School and Junior High School

Background and Purpose

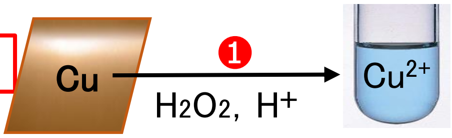
【Motivation for Research】

Textbook[1)]



Copper is not oxidized by dilute sulfuric acid.

Experiment

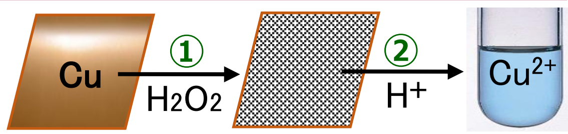


Copper dissolves when hydrogen peroxide is added.

What is the process of reaction ❶ ?

【Researching References】

"Commentary" in the References[2)]

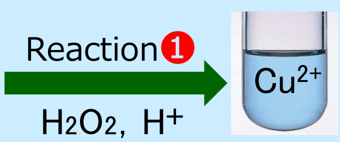


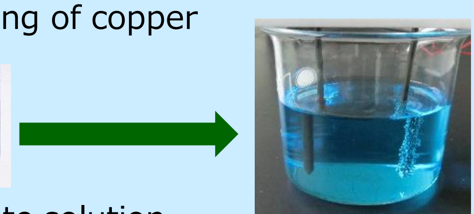
Copper oxide ?

The process is not described in detail.
(Composition of copper oxide is unknown)
Arguable experimental results are not presented.

【Purpose of Research】

:Elucidate the detailed process of the reaction ❶ for the recycling of copper





"Urban Mining[3)]"
:Metal resources accumulated in industrial waste without being reused

Copper(II) sulfate solution

Electrolytic refining[4)]

Hypothesis

Based on the References , the reaction❶ would follow this path.

[Copper metal]→[Copper oxide(CuO,Cu_2O)]→[Cu^{2+}]

Methods

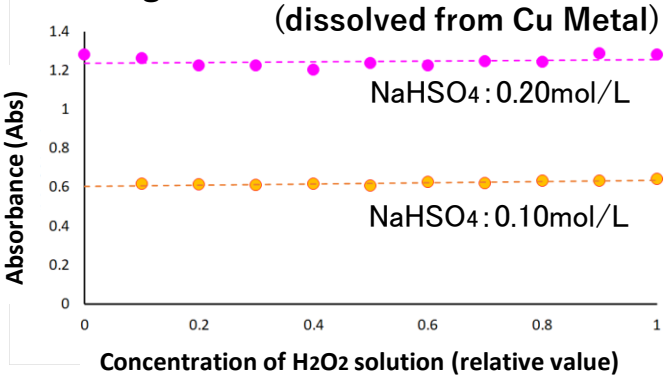
- Compared the amount of Cu^{2+} under three different conditions.
  - (1) Concentration of hydrogen peroxide solution (total volume :10 mL)
  - (2) Sources of Cu^{2+} (copper metal, copper oxides)
  - (3) Molar concentration of $NaHSO_4$
- The absorbance of Cu^{2+} (wavelength 808 nm) was measured.
  - ➡ Absorbance was compared as the concentration of Cu^{2+} produced.

Conditions

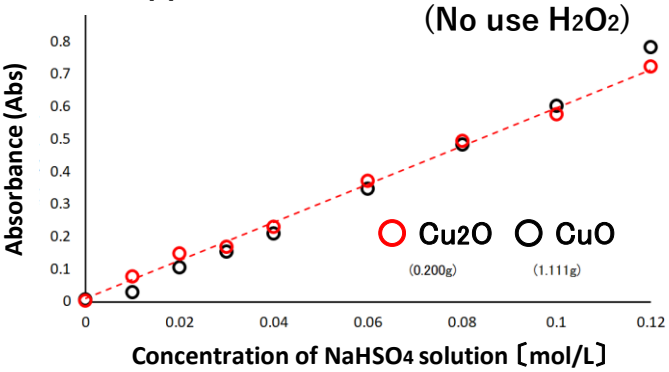
	Concentration of H_2O_2 (in 10mL)	Sources of Cu^{2+}	Molar concentration of $NaHSO_4$
● (magenta)	Dilute commercial reagent(35%)	Copper Metal	Constant (fixed at 0.20mol/L)
● (orange)	Dilute commercial reagent(35%)	Copper Metal	Constant (fixed at 0.10mol/L)
○ (red)	Concentration 0% (pure water)	Cu_2O	0.00～0.12mol/L
○ (black)	Concentration 0% (pure water)	CuO	0.00～0.12mol/L
● (red)	Constant (35% commercial reagent)	Cu_2O	0.00～0.20mol/L
● (black)	Constant (35% commercial reagent)	CuO	0.00～0.20mol/L
● (blue)	Constant (35% commercial reagent)	Copper Metal	0.00～0.20mol/L

Results

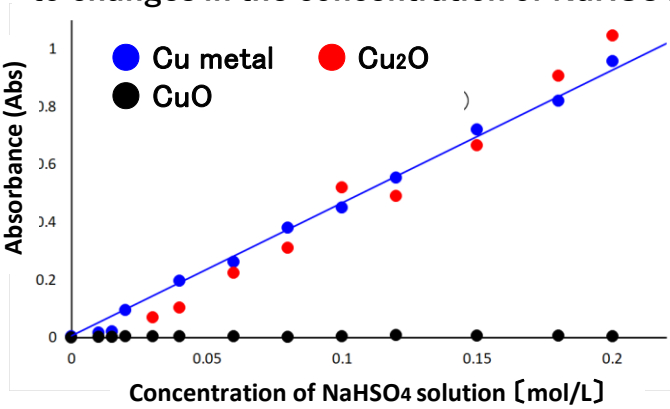
Change in the amount of Cu^{2+} in response to changes in the concentration of H_2O_2 (dissolved from Cu Metal)



Change in the amount of Cu^{2+} dissolved from copper oxides into $NaHSO_4$ solution (No use H_2O_2)



Change in the amount of Cu^{2+} in response to changes in the concentration of $NaHSO_4$



Discussion of Results

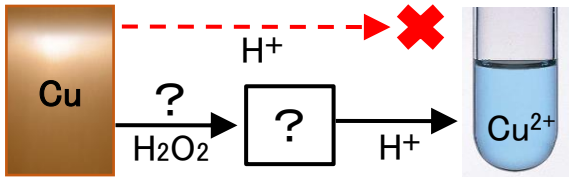
Dissolved amount of Cu

- Determined by the concentration of $NaHSO_4$
- Not related to the concentration of H_2O_2

Cu isn't dissolved by H^+, so Cu must dissolve in the following order.

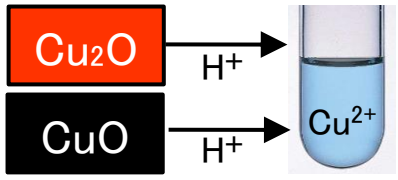
1. H_2O_2 has some effect on Cu

2. H^+ dissolves Cu as Cu^{2+}



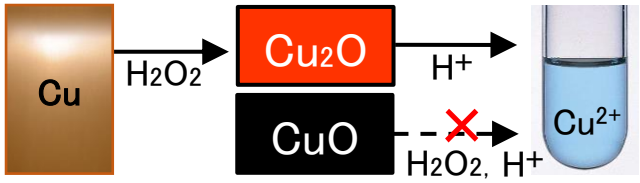
Both Cu_2O and CuO are equally soluble in $NaHSO_4$ solution, producing Cu^{2+}.

Cu was oxidized by H_2O_2 to form oxides (ex. Cu_2O,CuO). The oxides are considered to have been dissolved by H^+.



In $NaHSO_4$-acidic H_2O_2 solution, the same amount of Cu^{2+} is produced from Cu and Cu_2O, but not from CuO.

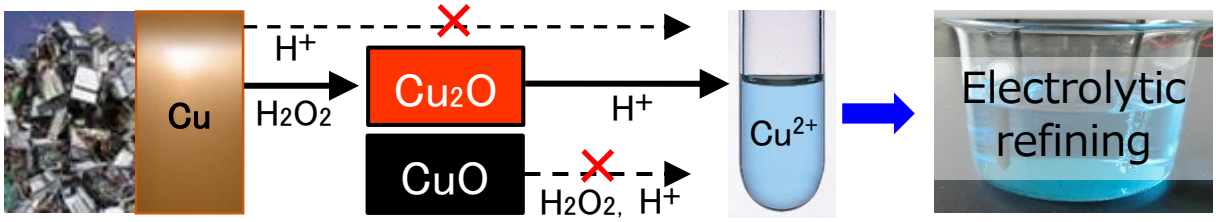
Cu is oxidized by H_2O_2, first to Cu_2O and then dissolved by H^+ to Cu^{2+} . CuO is not produced in the process.



Conclusion

Leaching reaction of Cu from "urban mines" by strong acidic H_2O_2 solution.

Finally H_2O_2 becomes H_2O and O_2.
Cu is recycled by electrolytic refining.



References

1) YAMAUCHI Kaoru, et *al.*, Revision Highschool Basic Chemistry, DaiichiGakusyuSha, **2016**, 174-176
2) KATO Shunji, "Dssolution of Copper by Hydrogenperoxide",KagakuKyouiku,**1986**, *34* (3), 50-51
3) National Institute for Materials Science, "Introduction of NIMS analytical study results", https://www.nims.go.jp/research/elements/rare-metal/urban-mine/index.html, 11 July 2022
4) YAMAUCHI Kaoru, et *al.*, Revision Highschool Chemistry, DaiichiGakusyuSha, **2017**, 117