

5 Revisiting the classical chemical data: solubility of GeO₂

Solubility plays an important role for all chemical studies. These data need to be continuously evaluated and updated in the light of the modern state-of-the-art instrumentations. We have noted an interesting observation on the solubility data of GeO₂, a high-end technological material, over the years in the Hand book of Chemistry and Physics. According to the 52nd edition GeO₂ is insoluble in concentrated HCl and no information is given on its solubility in other acids [Weast, 1971, 1972], while the 90th edition says GeO₂ is insoluble in water and the handbook is silent about the solubility of GeO₂ in other acids like HNO₃ and H₂SO₄ [David, 2010].

5.1 Experimental

5.1.1 Chemicals and Solution preparation

We have studied the solubility of GeO₂ in various strengths of HNO₃ and HCl with the help of inductively coupled plasma optical emission spectrometry (ICP-OES). Suprapure and GR grade HCl, HNO₃ and Germanium (IV) oxide (99+ grade) were procured from E. Merck Germany and OPTIMA HNO₃ from Canada. The ultrapure water with a maximum resistivity of 18.2 MΩ-cm was obtained from Bransted NANOpure® Diamond™, Thermo Scientific, Germany was used throughout the experiment.

Fixed amount of GeO₂ was taken into various strength of acids. It was then shaken for 10 min. with help of mechanical shaker and filtered with 42 whatmann paper. Finally, all the solutions were taken for ICP-OES study. For the ICP-OES calibration, a 2% of nitric acid blank solution and standard solutions were prepared from the stock standard solutions of 1000 ppm by dilution with 2% nitric acid.

5.1.2 Instrumentation

All measurements were carried out using a inductively coupled plasma optical emission spectrometry (Model no. iCAP 6500 duo, Thermo Fisher Scientific) with 7 pm

resolution at 200 nm. The employed operating conditions are listed in **Table 3.2**, page 37 and the selected emission lines for Ge were 206.866 nm, 209.426 nm and 219.871 nm respectively.

5.2 Results

We observed that the solubility of GeO_2 in concentrated HCl and HNO_3 are as high as 17.5 mg and 70.3 mg per litre of the respective acids and solubility also changes with HNO_3 acid strengths. Solubility trends of GeO_2 in various acid strengths are given below in tabular (**Table 5.2**) and graphical (**Figure 5.1**).forms.

Table 5.2 Solubility trend of GeO_2 in various acid strengths.

Acid strength (M)	Solubility (ppm)
GR HNO_3 (15.44)	30.1
OPTIMA HNO_3 (14.78)	70.3
HNO_3 (12)	99.8
HNO_3 (9)	240.5
HNO_3 (6)	452
HNO_3 (3)	409.3
HNO_3 (1)	123.16
HNO_3 (0.1)	159.1
HNO_3 (0.01)	45.95
GR HNO_3 (15.44) at 5°C	22.5
OPTIMA HNO_3 (14.78) at 5°C	58.33
GR HCl (11.33)	1
Suprapure HCl (9.46)	17.5

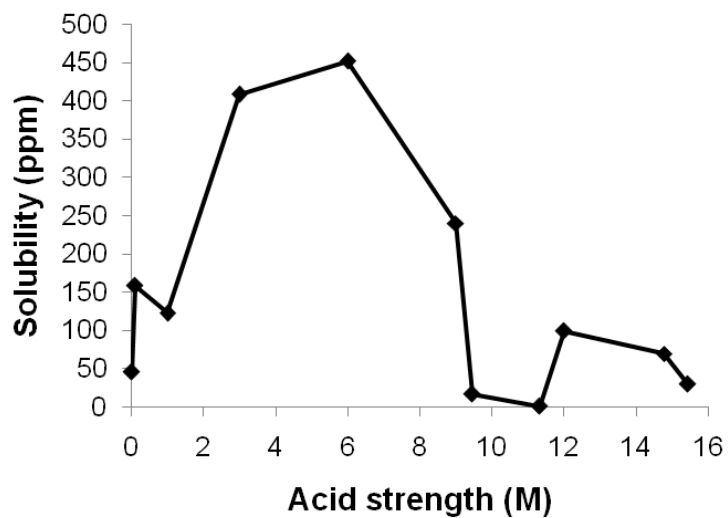


Figure 5.1 Solubility trend of GeO_2 in various acid strengths.

5.3 Conclusion

When the analytical goal for elemental analysis is in ppb or ppt levels, solubility of particular compound must be verified.

References

David RL. CRC Handbook of Chemistry and Physics, 90th Edition, CRC Press/Taylor and Francis, Boca Raton, FL (CD-ROM Version 2010).

Weast RC. CRC Handbook of Chemistry and Physics. 52nd Edition. Cleveland, Ohio. (1971-1972).