Application Note

Temperature dependence of viscosity of ionic liquid

Industry	:	Electricity & electronics
Instrument	:	Viscometer
Measurement method	:	Electro Magnetically Spinning Method
Standards	:	

1. Scope

Ionic liquid is a substance (salt) which is liquid at 100 ° C or less and consists only of ions.
It is a material that can create various physical properties by the design of anion and cation composed, and combinations thereof.
Ionic liquids have characteristics such as almost no vapor pressure, no flammability / flammability, high thermal stability, liquid state in wide temperature range, relatively low viscosity, high ionic conductivity, and so on.
In addition, since certain ionic liquids have the property of being insoluble in water and low polarity organic solvents, they can be used as a solvent for separation and purification, which can be reused during extraction of reaction products. Also it is a substance that has attracted attention as it can be used as an electrolyte.
An example of measuring the temperature dependence of the dynamic viscosity of ionic liquid using an EMS viscometer that can be measured by sealing, sterilization and non-contact was shown below.

2. Precautions

Ionic liquid should be sampled under the nitrogen atmosphere and be measured in sealed state because of high hygroscopicity.

3. Post-measurement procedure

The sample container and the sample are discarded appropriately.

4. Apparatus

- EMS Viscometer
- Control Laptop

5. Reagents

- Sample : Ionic liquid (1-butyl-2.3-dimethylimidazolium Tetrafluorodorate)

6. Procedure

1) Enter the following conditions in measurement condition of the sequence mode of control software.
   - ✧ Measurement mode :Sequence mode
   - ✧ Measurement temperature :20-150℃(heat up at 10℃ interval)
   - ✧ Motor rotation speed :1,000 rpm
   - ✧ Measurement time :II (10 seconds) in 50℃ or less
     I (1 second) in 60℃ or more
   - ✧ Repeat count :5 times
   - ✧ Measurement interval :5 seconds
   - ✧ Waiting time for temperature stability :10 minutes
2) Place an aluminum spherical probe of φ 2 mm and a sample of 300 μL in a container, cover with a cap and packing, set the sample container in the EMS Viscometer, and click the measurement button.

7. Example

The temperature dependence of viscosity of ionic liquid at 20-150℃ can be confirmed.
The measurement results are shown in Figure 1 and Table 1, 2.

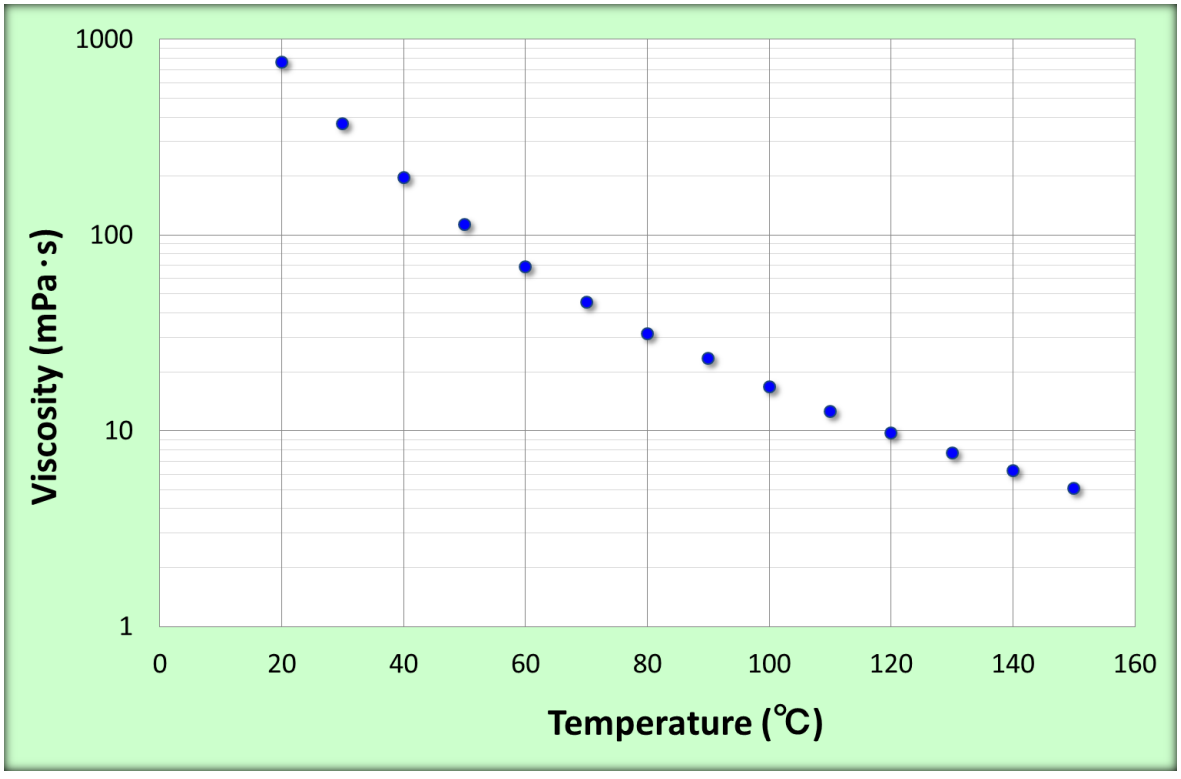

Figure 1. Measurement result about the temperature dependence of viscosity of ionic liquid

Table 1. Temperature dependence of viscosity of ionic liquid (20-80℃)

(mPa･s)

	Temperature (℃)						
	20	30	40	50	60	70	80
1st	764	369	198	113	69.5	45.5	31.2
2nd	764	371	198	113	68.8	45.4	31.3
3rd	767	371	198	113	68.7	45.9	31.1
4th	770	370	197	113	68.2	45.4	31.2
5th	765	369	197	114	68.9	45.0	31.1
Mean	766	370	198	113	68.8	45.4	31.2
Standard deviation	3	1	1	0	0.5	0.3	0.1
RSD (%)	0.3	0.3	0.3	0.4	0.7	0.7	0.3

Table 2. Temperature dependence of viscosity of ionic liquid (90-150℃)

(mPa･s)

	Temperature (℃)						
	90	100	110	120	130	140	150
1st	23.5	16.7	12.5	9.70	7.73	6.33	5.05
2nd	23.5	16.7	12.6	9.68	7.73	6.38	5.06
3rd	23.5	16.6	12.5	9.72	7.93	6.29	5.02
4th	23.5	16.7	12.6	9.73	7.73	6.19	5.02
5th	23.5	16.7	12.5	9.70	7.68	6.19	5.02
Mean	23.5	16.7	12.5	9.71	7.76	6.28	5.03
Standard deviation	0.0	0.0	0.1	0.02	0.10	0.08	0.02
RSD (%)	0.0	0.3	0.4	0.2	1.3	1.4	0.4

8. Summary

Though the viscosity of ionic liquid is easy to change by hygroscopicity, it can be measured stably without hygroscopicity by purging the nitrogen into the sample container. Moreover, it is possible to measure in about 1.5 hours automatically in a wide temperature range of 20-150℃ by utilizing the sequence mode.

9. References

None.