Increasing the Melting Ability of Glass Batch by Batch Modification

International Conference on Applied Physics and Material Applications (ICAPMA2013) 20-22 February 2013

ศูนย์เชี่ยวชาญด้านแก้ว
Thailand Center of Excellence for Glass

E. Meechoowas[1], K. Tui-ai[2], K. Tapasa[1], U. Naknikam[1] and T. Jitwatcharakomol[1]
[1]Thailand Center of Excellence for Glass
Department of Science Service,10400, Thailand
[2]Faculty of Science, Maejo University, Chiangmai, 50290 Thailand
Tel.: +0-662-201-7368 Email address: ekarat@dss.go.th

Abstract

The soda-lime glass with the composition of 74SiO_2-18Na_2O-6CaO-B_2O_3-Al_2O_3 thermodynamically requires the exploited heat of 557 kW/ton of glass to transform raw materials into glass. The objective of this project is to modify the soda-lime glass batch by using wollastonite instead of limestone and pyrophyllite instead of aluminium hydroxide. The exploited heat of the batch with wollastonite is reduced to 546 kW/ton of glass while the batch with wollastonite and pyrophyllite is decreased to 550 kW/ton of glass. According to Batch-Free Time testing, it is found that the melting ability of both modified batches is higher than of the original batch, while the properties of glass are slightly changed. This implies that the modified batch requires a lower melting energy than the original batch.

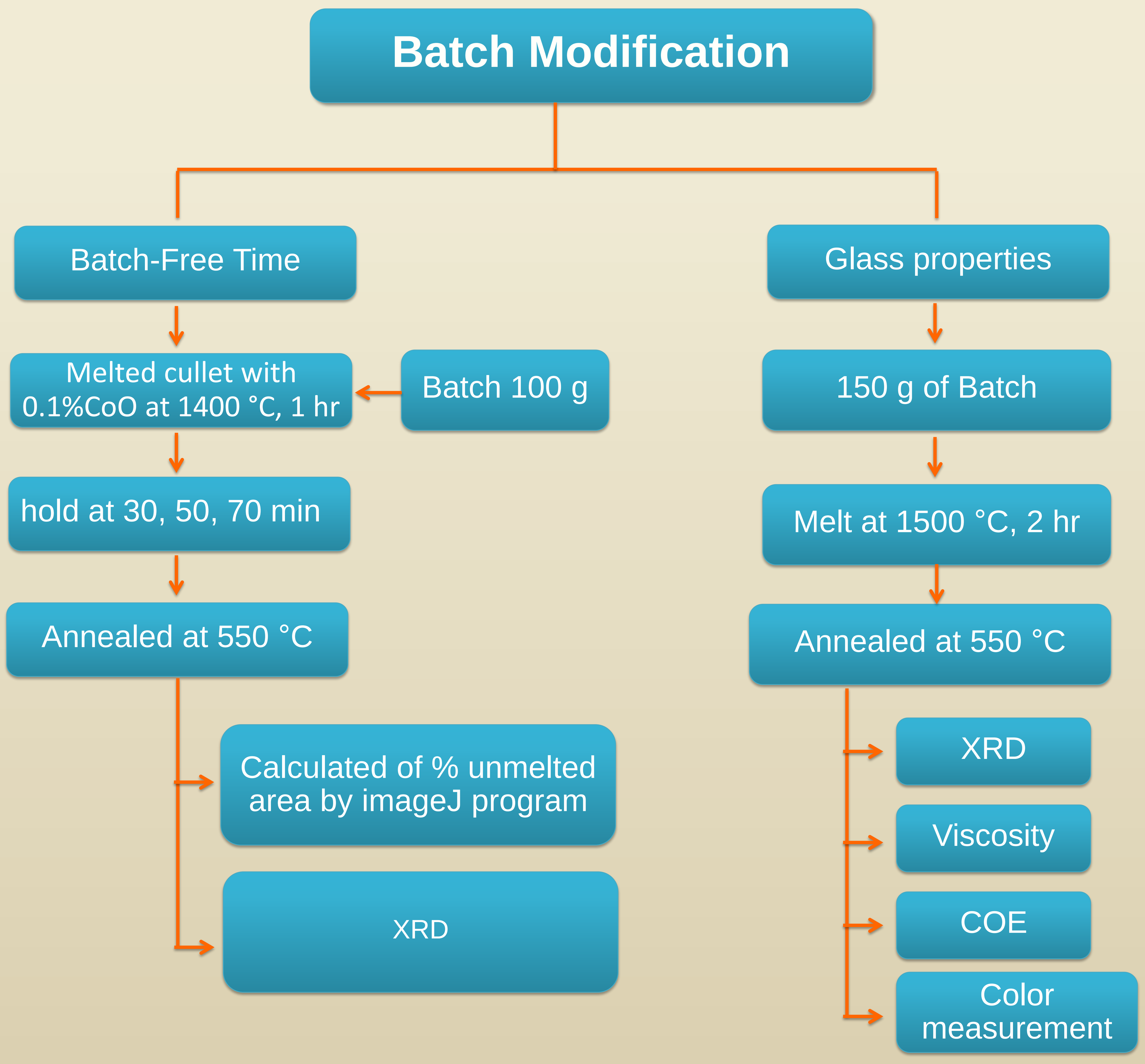
Introduction

Glass melting requires a high energy to transform batch to glass. There are many researches that study on the reduction of the glass melting energy. Our previous studies of batch modifications found that using wollastonite ($CaSiO_3$) instead of limestone ($CaCO_3$) and using feldspar ($KAlSiO_3$) and pyrophyllite ($Al_2Si_4O_{10}(OH)_2$) instead of alumina in a glass batch showed the possibility of lowering the melting energy. In this project, the batch modification of soda-lime glass is studied by using wollastonite instead of limestone and pyrophyllite instead of aluminium hydroxide in the same batch.

Objective

The batch modification of soda-lime glass is studied by using wollastonite instead of limestone and pyrophyllite instead of aluminium hydroxide.

Procedure



Acknowledgements

This study is a part of the study of batch-to-melt conversion analysis method for improving energy efficiency funding and supporting by Department of Science Service.

Result

Fig. 1a and 1b show the images of the batch containing some particles on the surface a) before and b) after image analyzing using imageJ program. Fig. 2 exhibits the percentage of unmelted area on the glass surface relative to the dwelling time. It shows that batch B and C are dissolved easier than batch A at 50 min, which most of raw materials are melted. According to the XRD result in Fig. 3 it is found that the remaining particles are silica. Table 1 shows the chemical composition of the resulting glasses. The result shows that Glass B and C has slightly different compositions from Glass A.

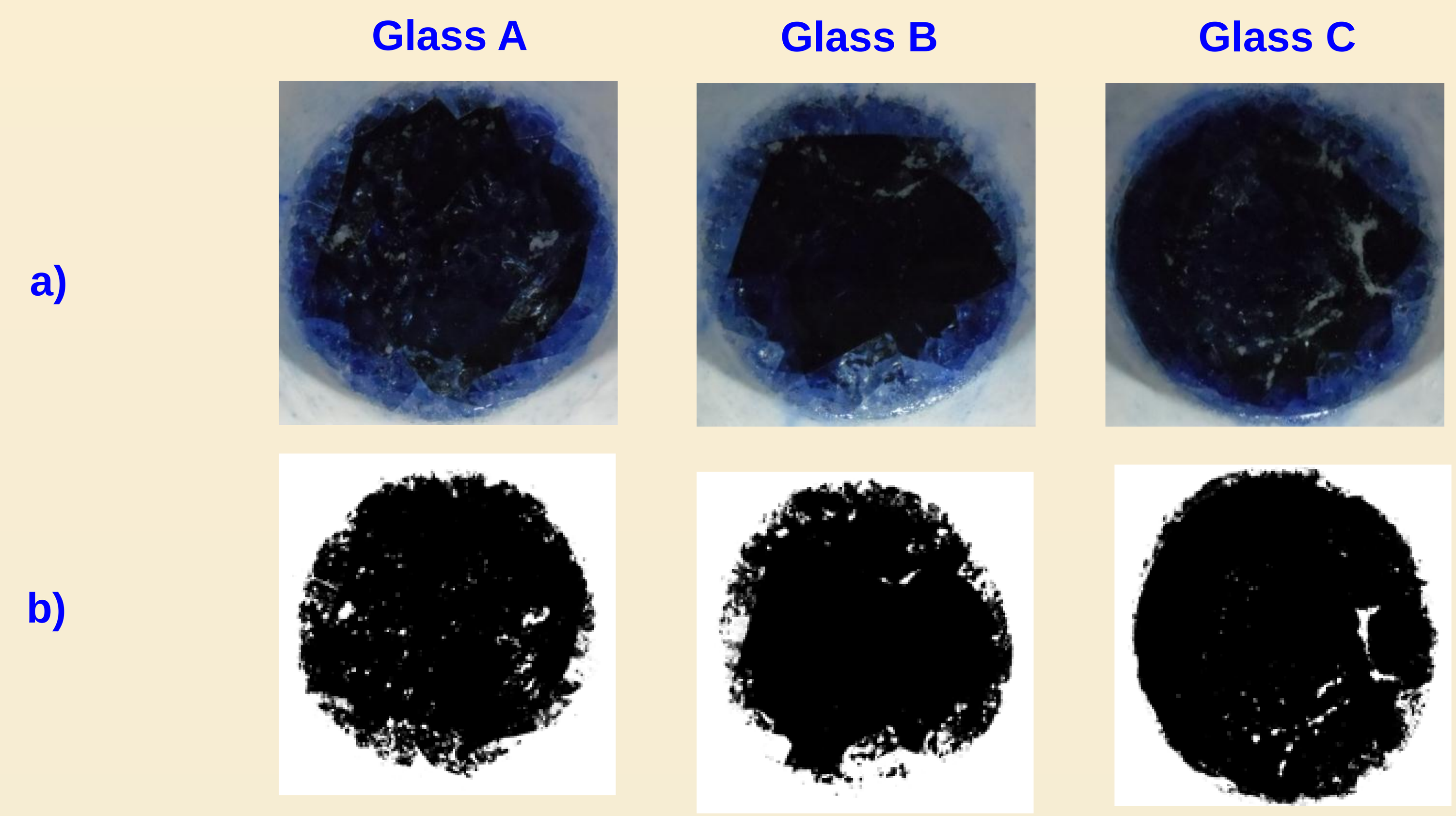


Fig. 1 The result of Batch-Free Time testing at 50 min. a) before b) after analyzed by imageJ program.

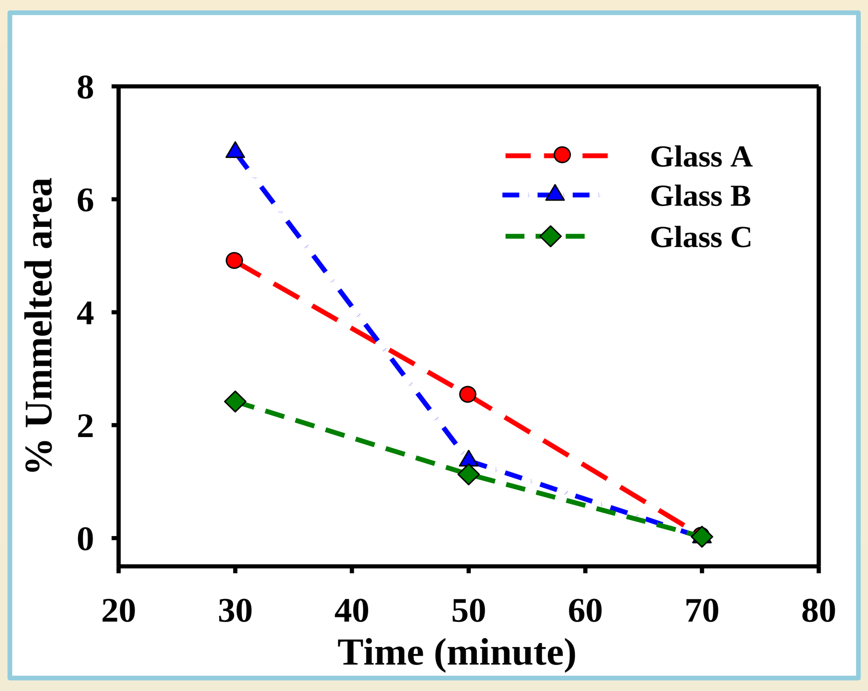


Fig. 2 The percentage of unmelted area on the glass surface relative to the dwelling time.

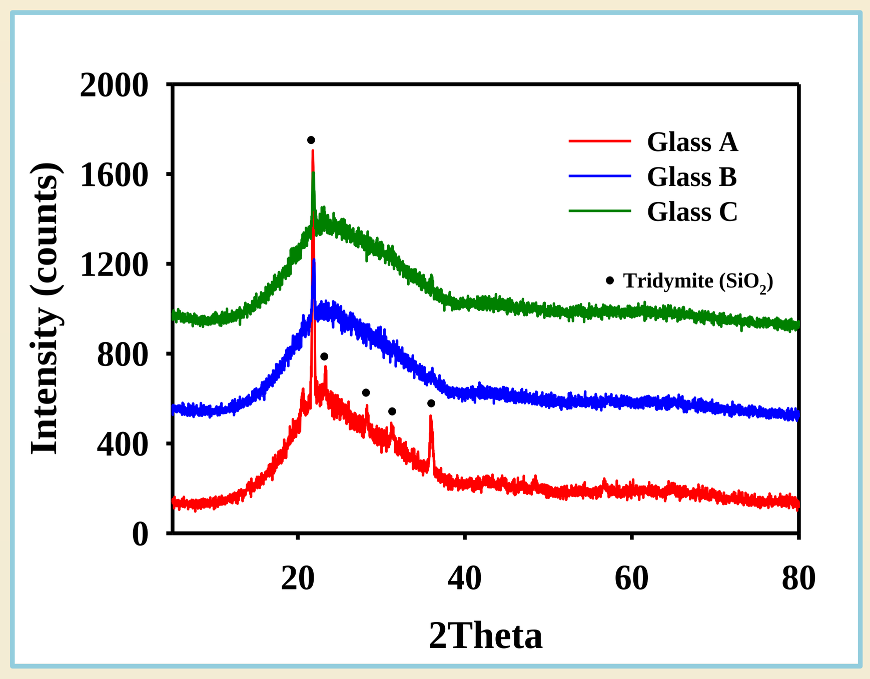


Fig. 3 The X-ray diffraction result of unmelted particles at 50 minute dwelling time.

Table 1. Chemical composition of glasses.

Composition [weight %]	Na_2O	MgO	Al_2O_3	B_2O_3	SiO_2	K_2O	CaO	TiO_2	Fe_2O_3	SO_3
Glass A	18.59	-	0.86	0.75	74.05	0.05	5.65	-	0.03	0.02
Glass B	17.98	0.25	0.84	0.83	74.23	0.05	5.75	0.01	0.04	0.02
Glass C	18.90	0.22	0.70	0.78	74.39	0.05	4.90	0.02	0.04	0.02

Fig. 4 presents the results of viscosity and thermal expansion. It shows that the viscosity and thermal expansion of Glass A, B, C are quite similar. However, the viscosity curves are slightly different, i.e. most of characteristic point of Glass B and C are lower than A.

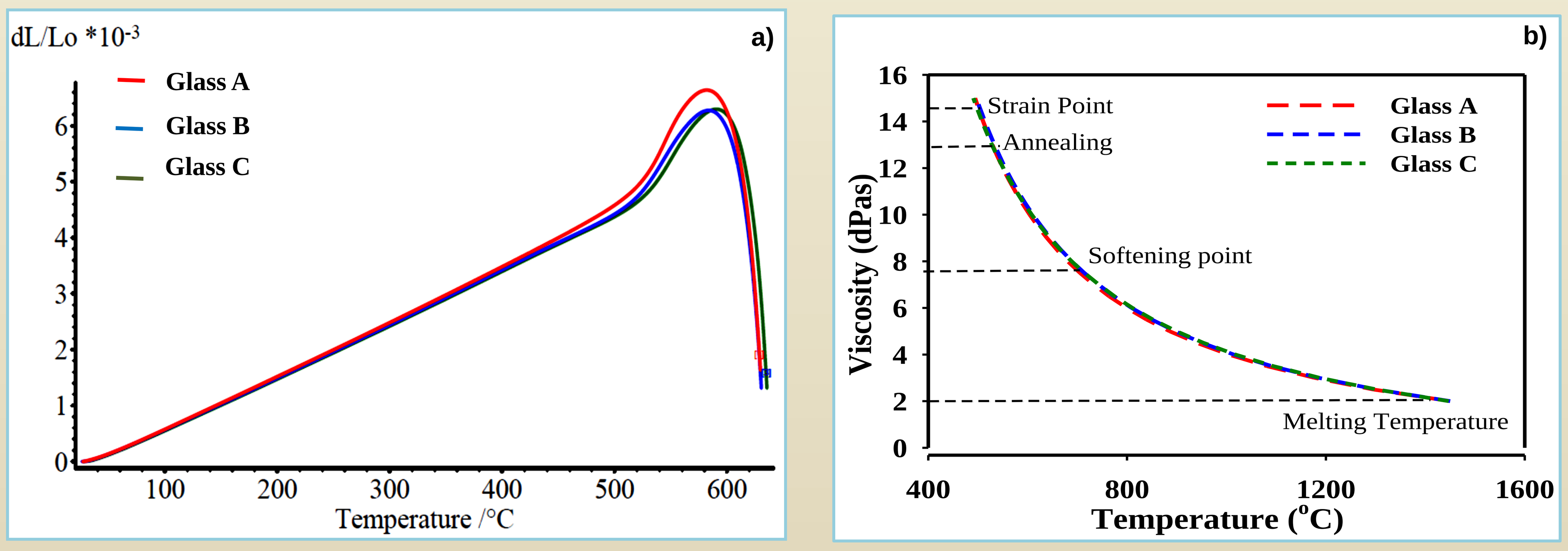


Fig 3. Thermal properties of glasses a) thermal expansion b) viscosity.

The result of the color determination in Table 2 points out that Glass B and C has a little greenish comparing to Glass A due to higher concentration of iron oxide (L*: lightness, a*: green-red and b*: blue-yellow).

Table 2. Calculated glasses color in CIE L* a* b* system

Glass	Color		
	L*	a*	b*
A	94.17	-0.43	0.45
B	92.98	-0.43	0.58
C	93.14	-0.46	0.77

Conclusions

The batch modification of soda-lime glass by using wollastonite instead of limestone and pyrophyllite instead of aluminium hydroxide shows a potential to reduce the melting energy. The glass produced from the modified batch contains similar chemical and themal properties to the original batch. Unfortunately, the modified batches produce the glass with a little greenish comparing to the original due to higher concentration of iron oxide. However, it is still in the range that can be controlled by decolorizing or reducing agent.