



Reaction Mechanisms of Magnesium Silicates with Carbon Dioxide in Microwave Fields

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Motivation

Sequestration of CO_2 as MgCO_3 Using Mg-Minerals as Feedstock

- 1) How to Improve kinetics?
- 2) How to minimize energy input?
- 3) How to avoid or minimize reagents?

Objectives

Long Term

Can microwave processing catalyze sequestration reactions such as :

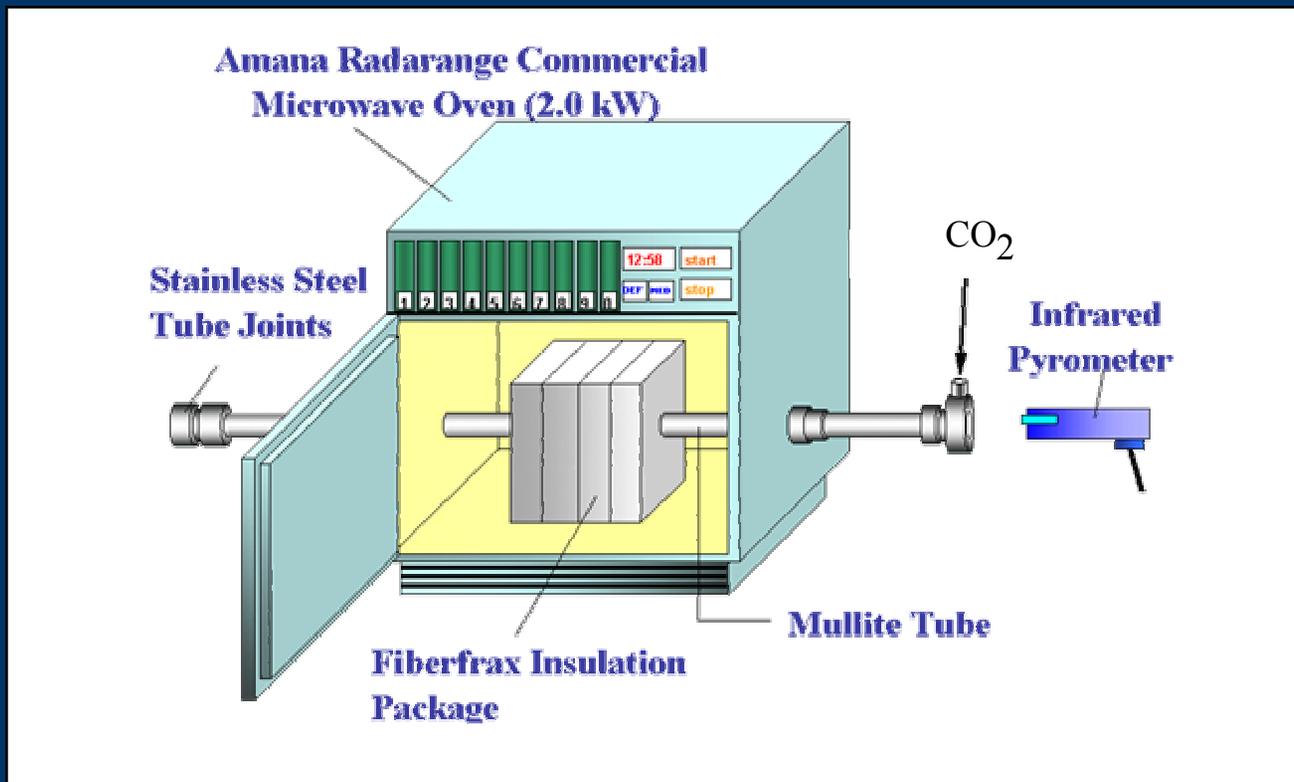


Short Term

Demonstrate efficacy of microwave enhancement of reaction rates by comparing kinetics – microwave vs. thermal- the dehydration reaction:



Scheme of the Tube Microwave Processing Setup



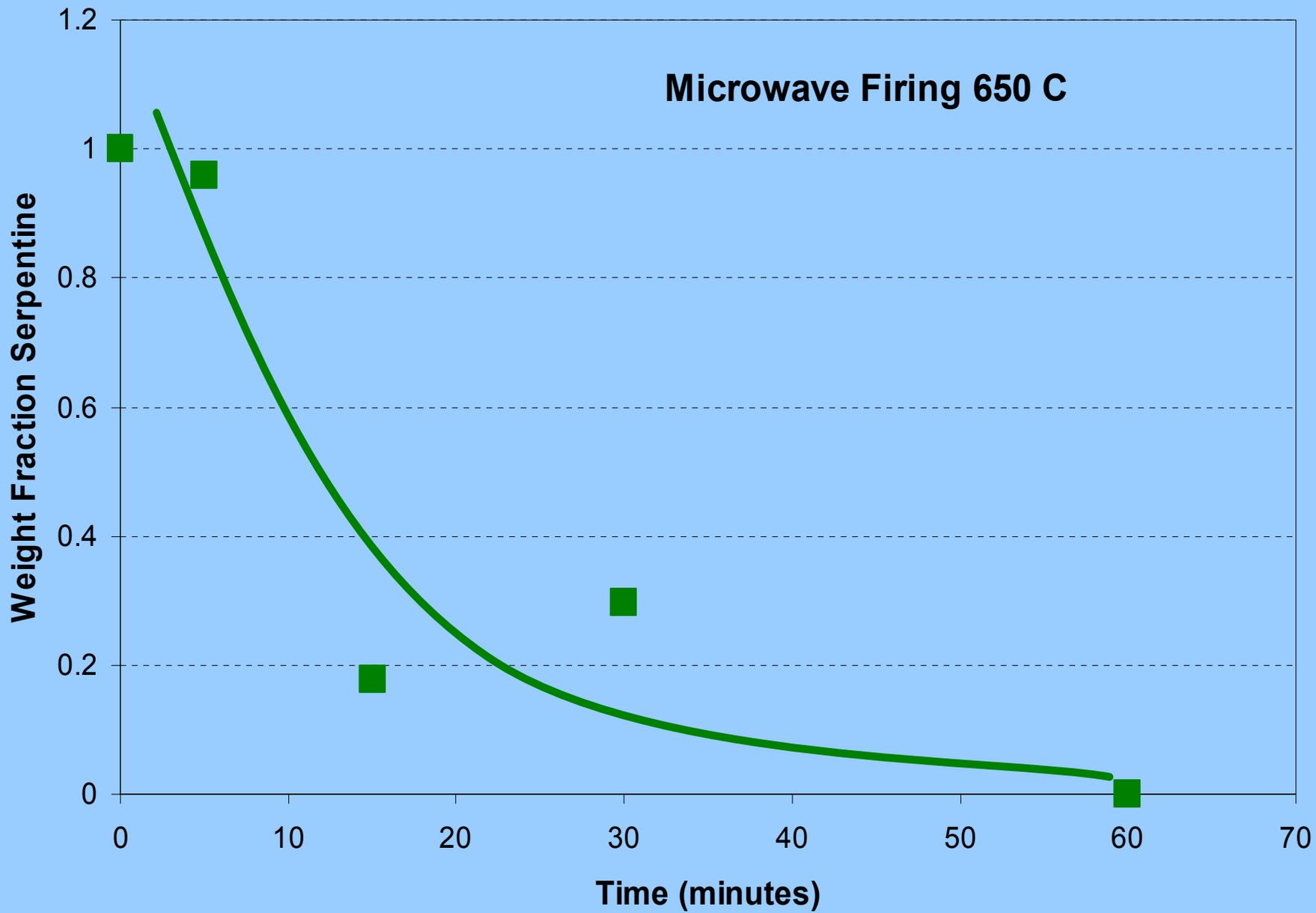
MICROWAVE PROCESSING SYSTEMS AT MPEC, MRI



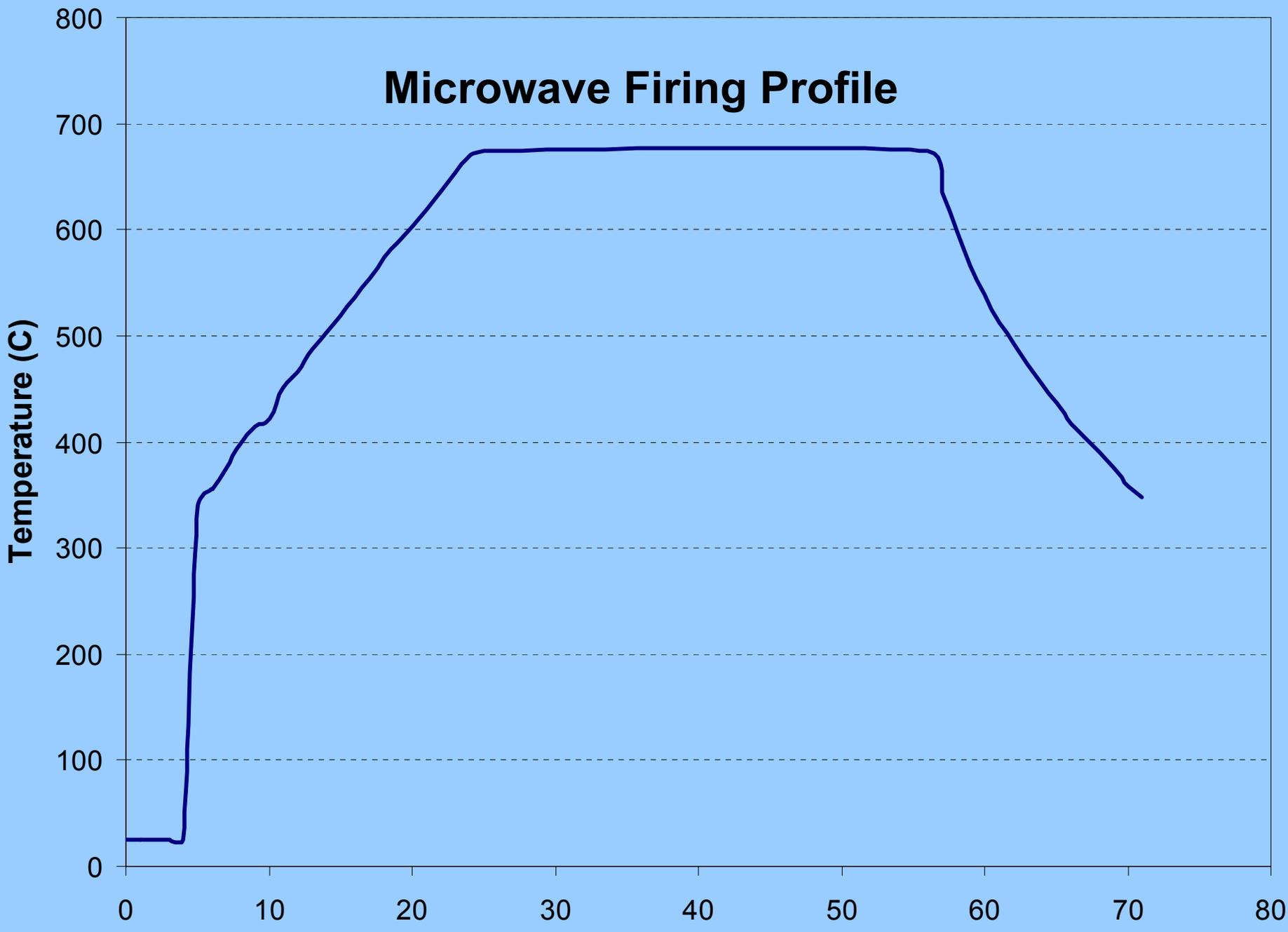
2.45 GHz, 2 kW Tube Microwave Processing Setup

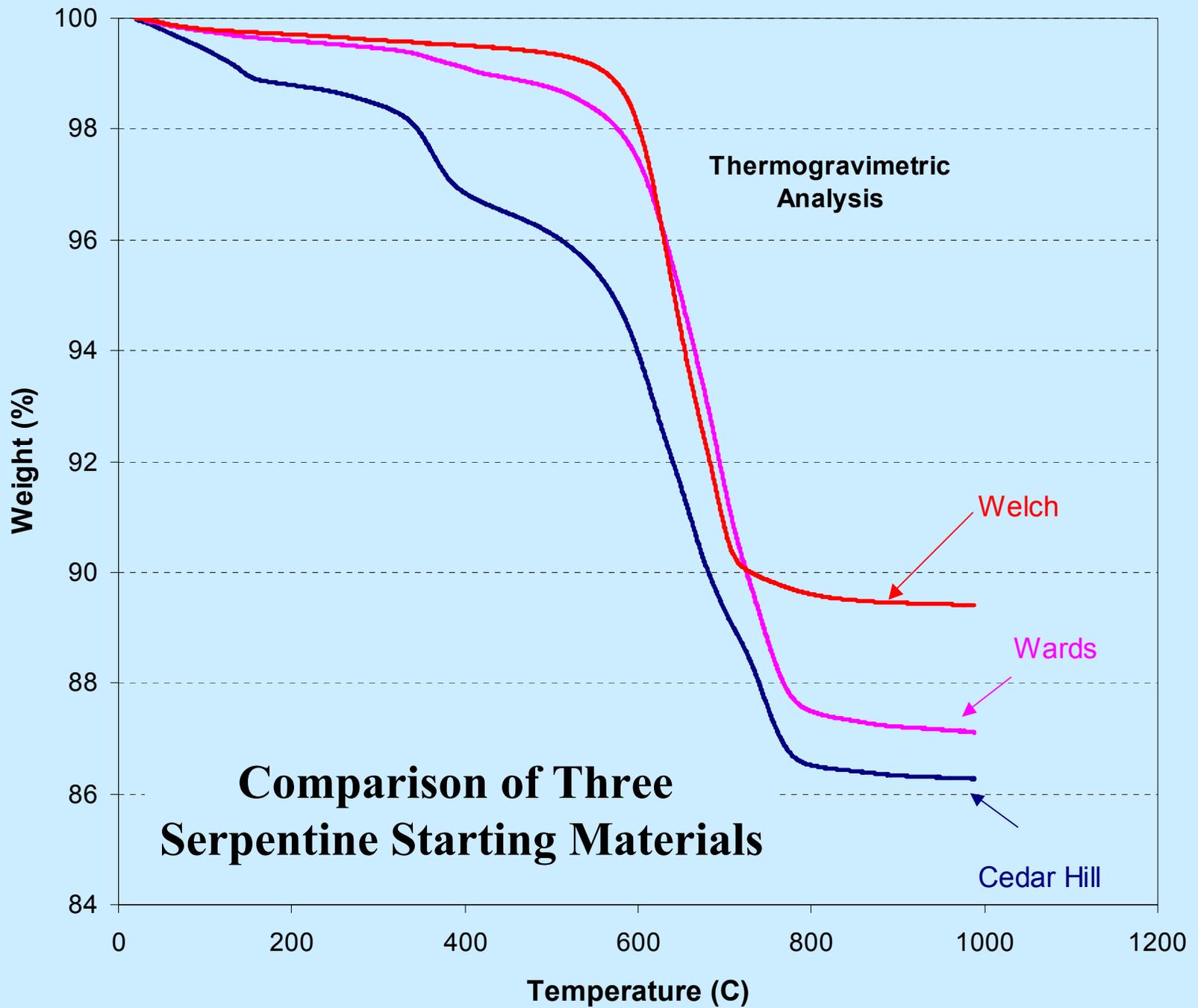


Microwave Firing 650 C

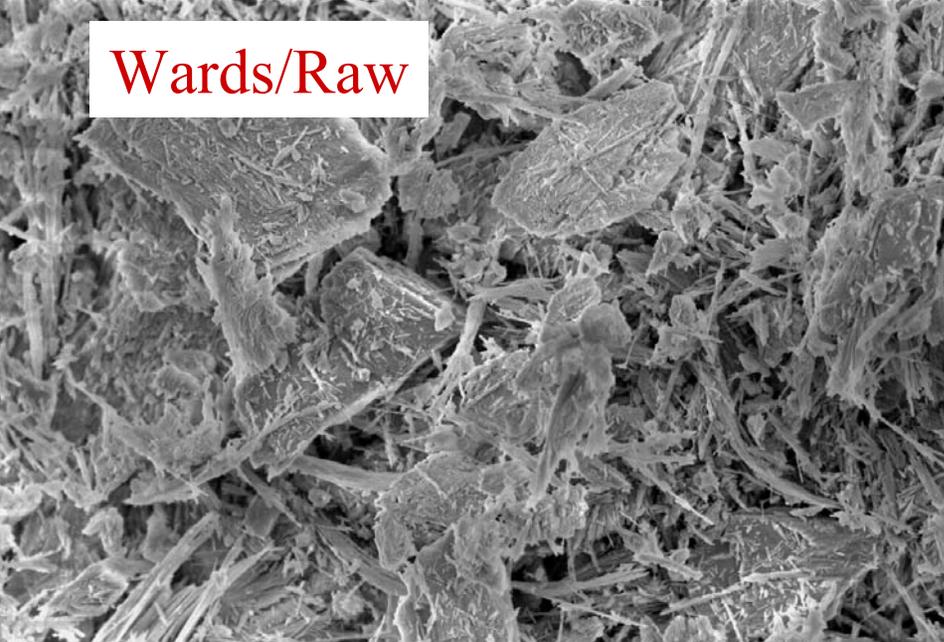


Microwave Firing Profile



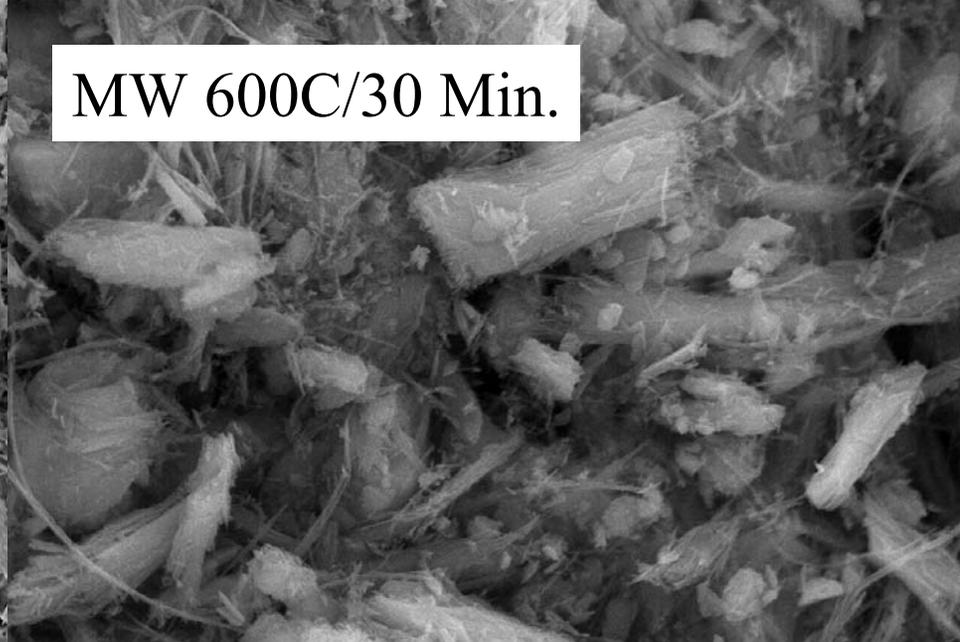


Wards/Raw



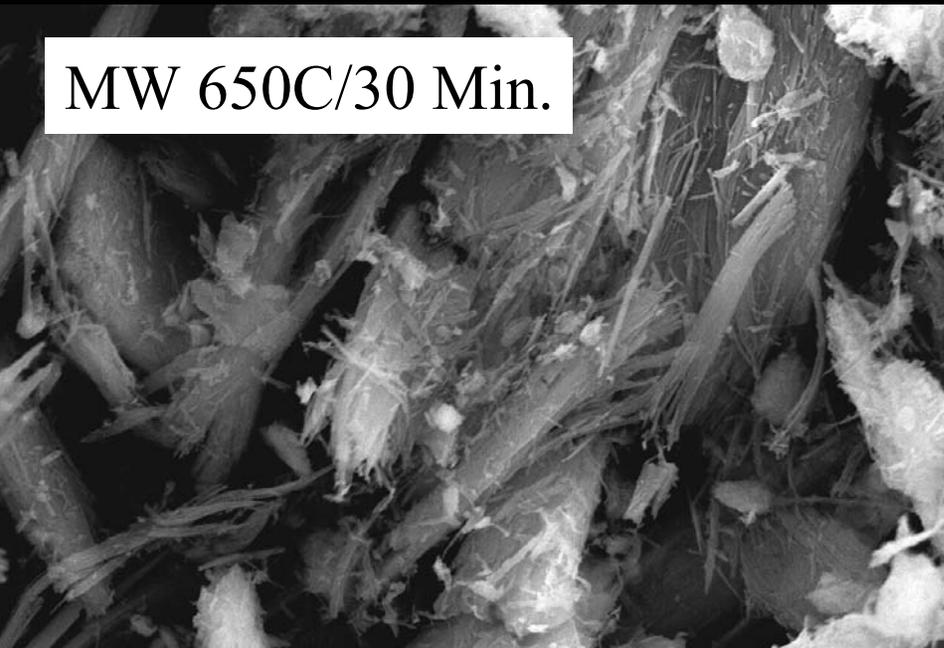
SE 01-Apr-03 Ward WD 6.9mm 5.00kV x3.0k 10um

MW 600C/30 Min.



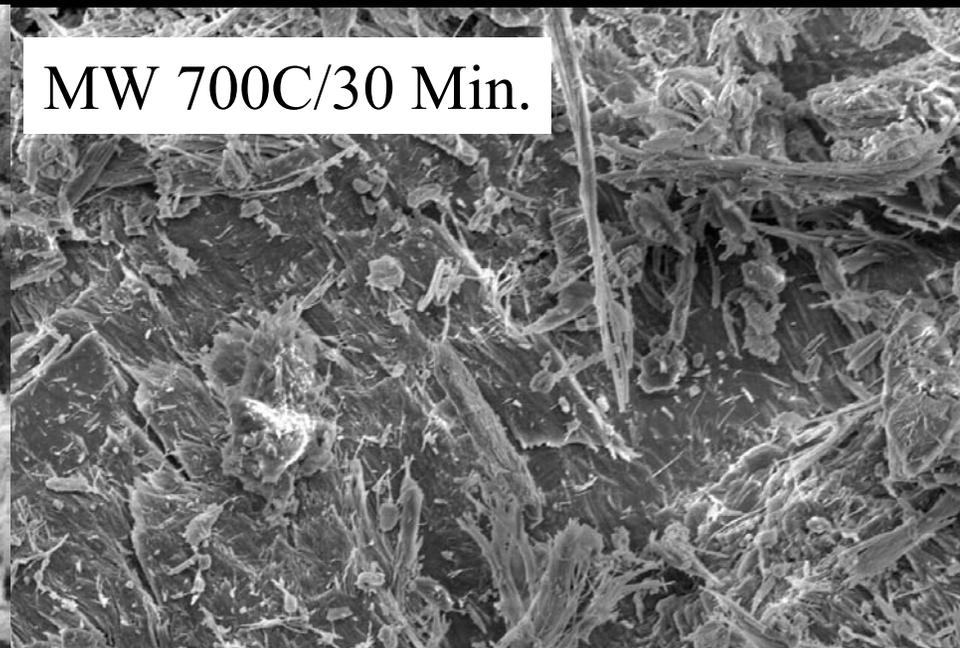
SE 24-Mar-03 WARDS WD 7.3mm 25.0kV x3.0k 10um

MW 650C/30 Min.



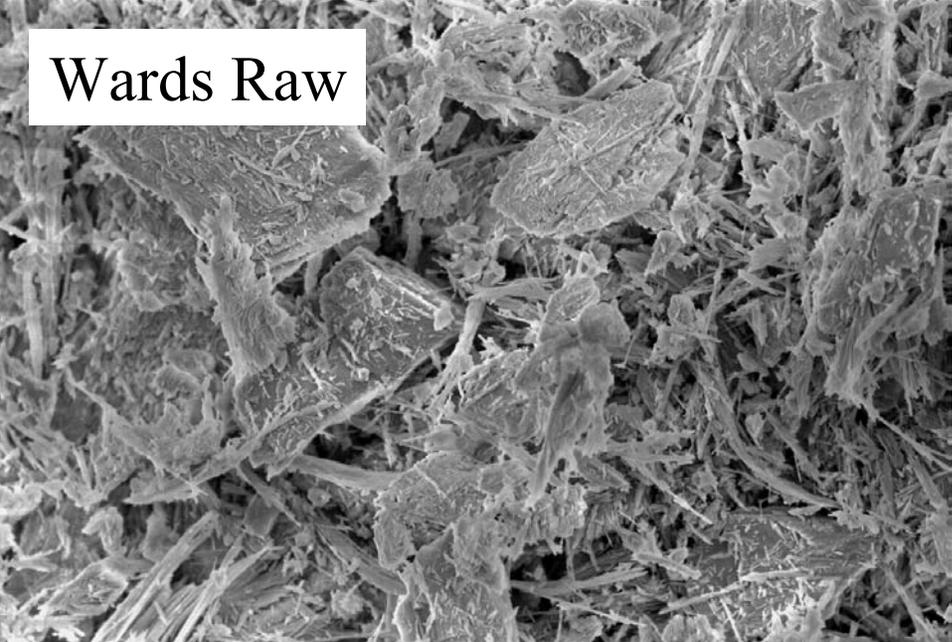
SE 24-Mar-03 WARDS WD 7.1mm 25.0kV x3.0k 10um

MW 700C/30 Min.



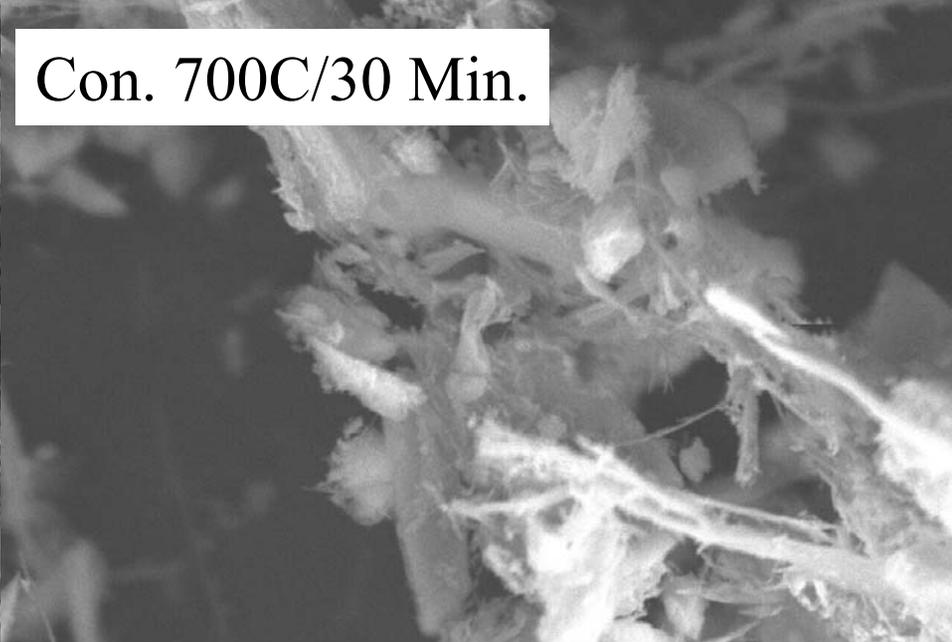
SE 01-Apr-03 Ward WD 7.6mm 5.00kV x3.0k 10um

Wards Raw



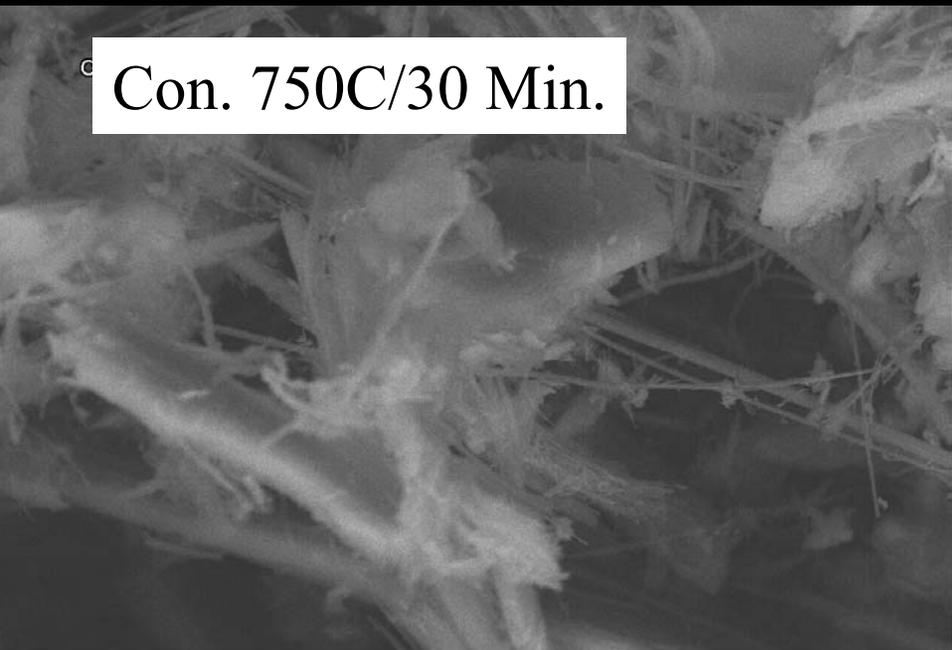
SE 01-Apr-03 Ward WD 6.9mm 5.00kV x3.0k 10um

Con. 700C/30 Min.



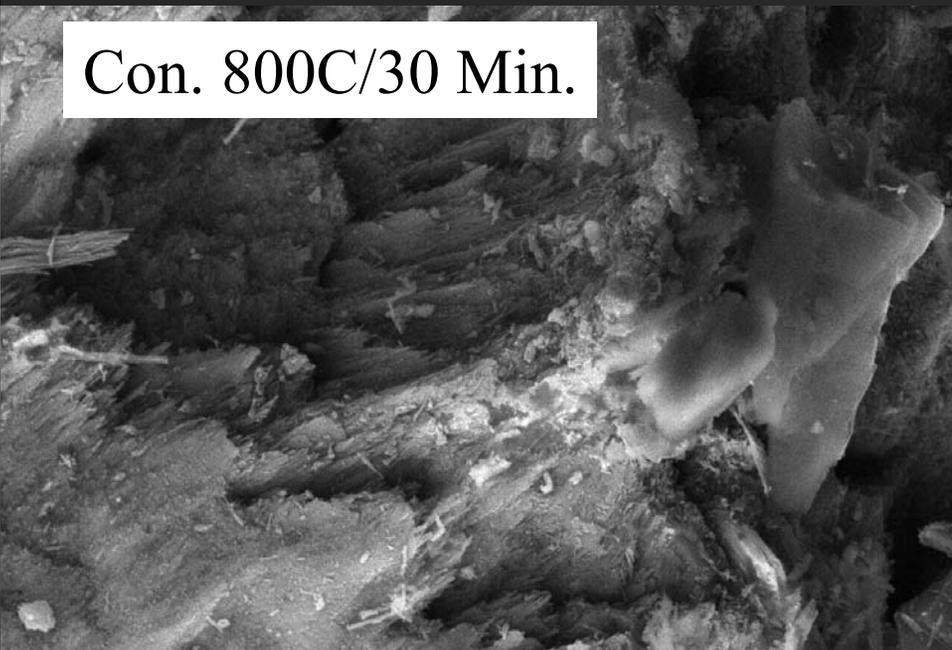
BSE1 04-Apr-03 WARDS WD 9.0mm 20.0kV x3.0k 10um

Con. 750C/30 Min.



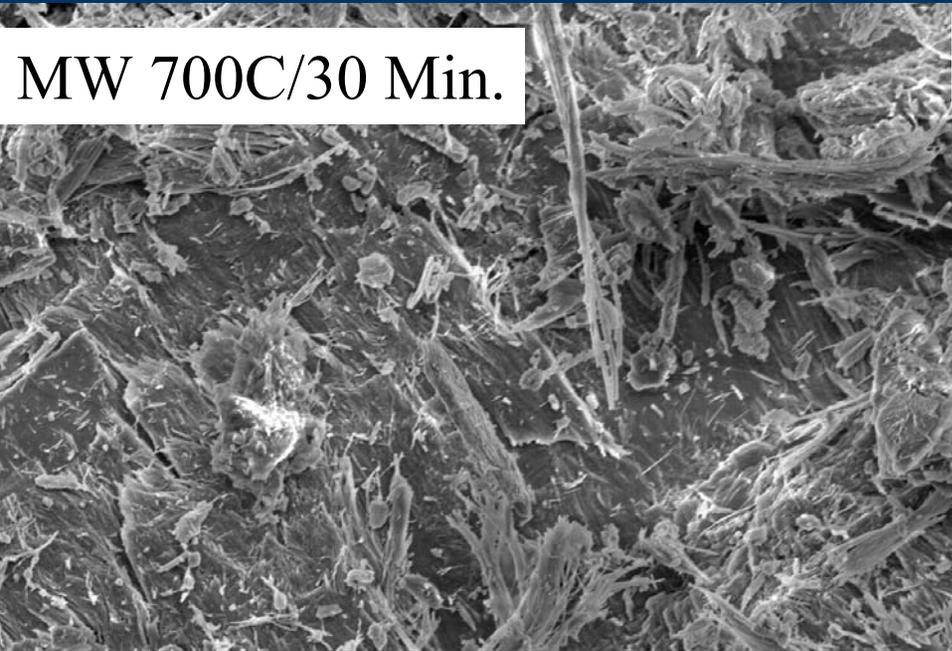
BSE1 07-Apr-03 wards WD10.4mm 20.0kV x3.0k 10um

Con. 800C/30 Min.



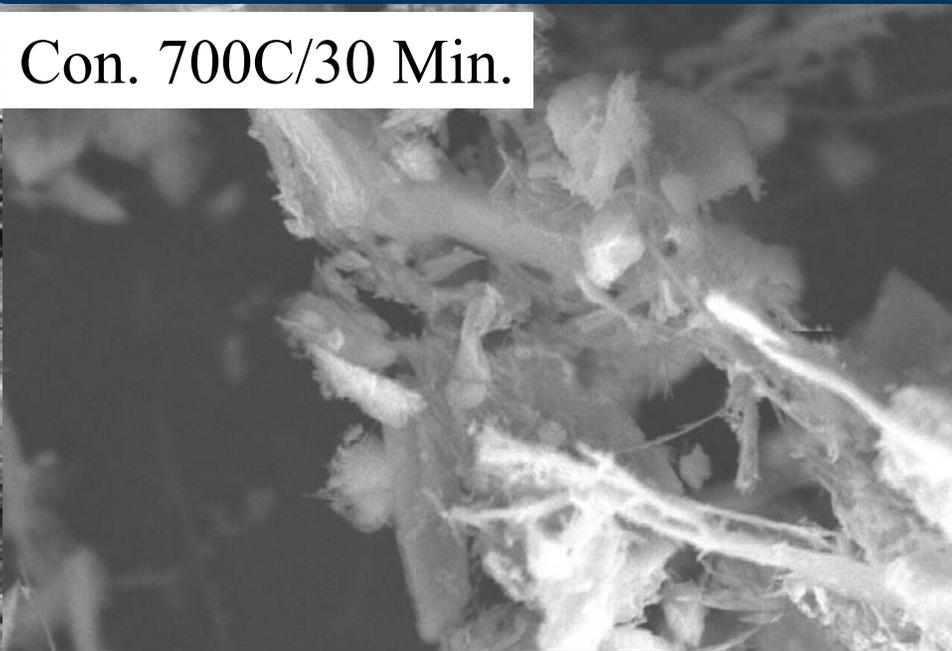
BSE1 07-Apr-03 wards WD10.1mm 20.0kV x3.0k 10um

Comparison of Microwave and Conventional Sintering



MW 700C/30 Min.

SE 01-Apr-03 Ward WD 7.6mm 5.00kV x3.0k 10um



Con. 700C/30 Min.

BSE1 04-Apr-03 WARDS WD 9.0mm 20.0kV x3.0k 10um

Bet Surface Area

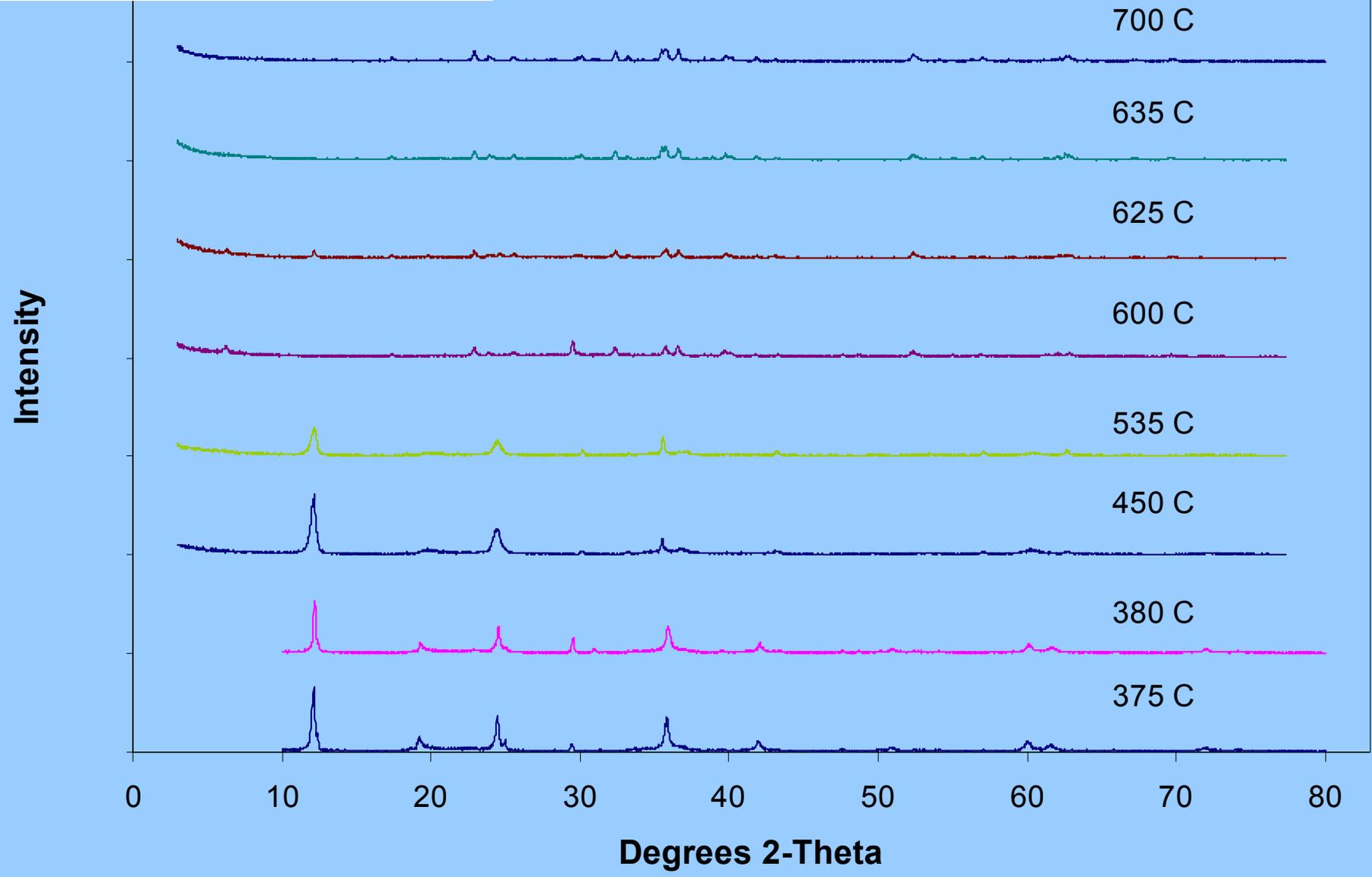
Conventional Firing

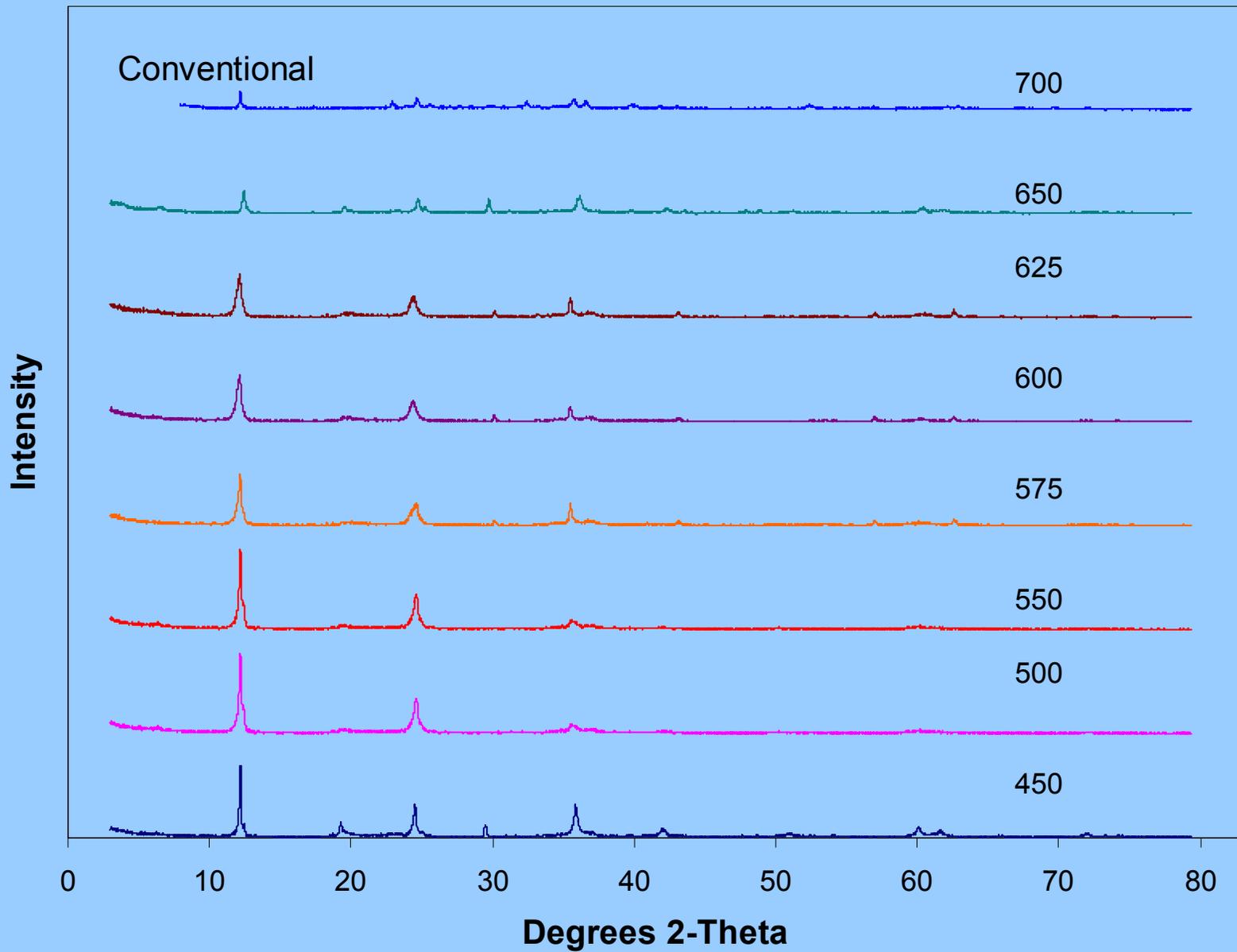
700 C	4.19	sq. m/gm
750 C	2.37	“
800 C	6.95	“

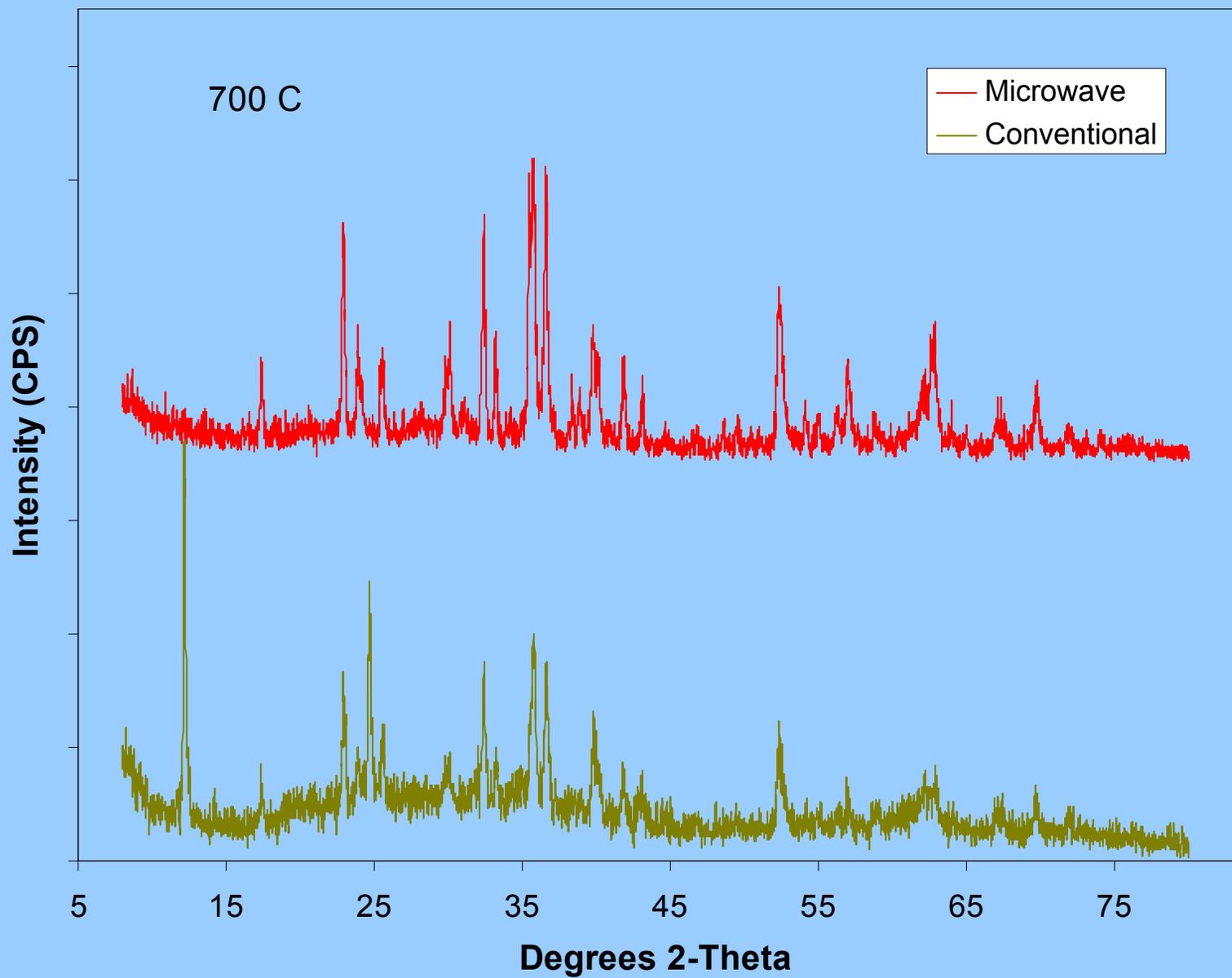
Microwave Firing

600 C	2.45	sq.m/gm
650 C	3.03	“
700 C	0.37	“

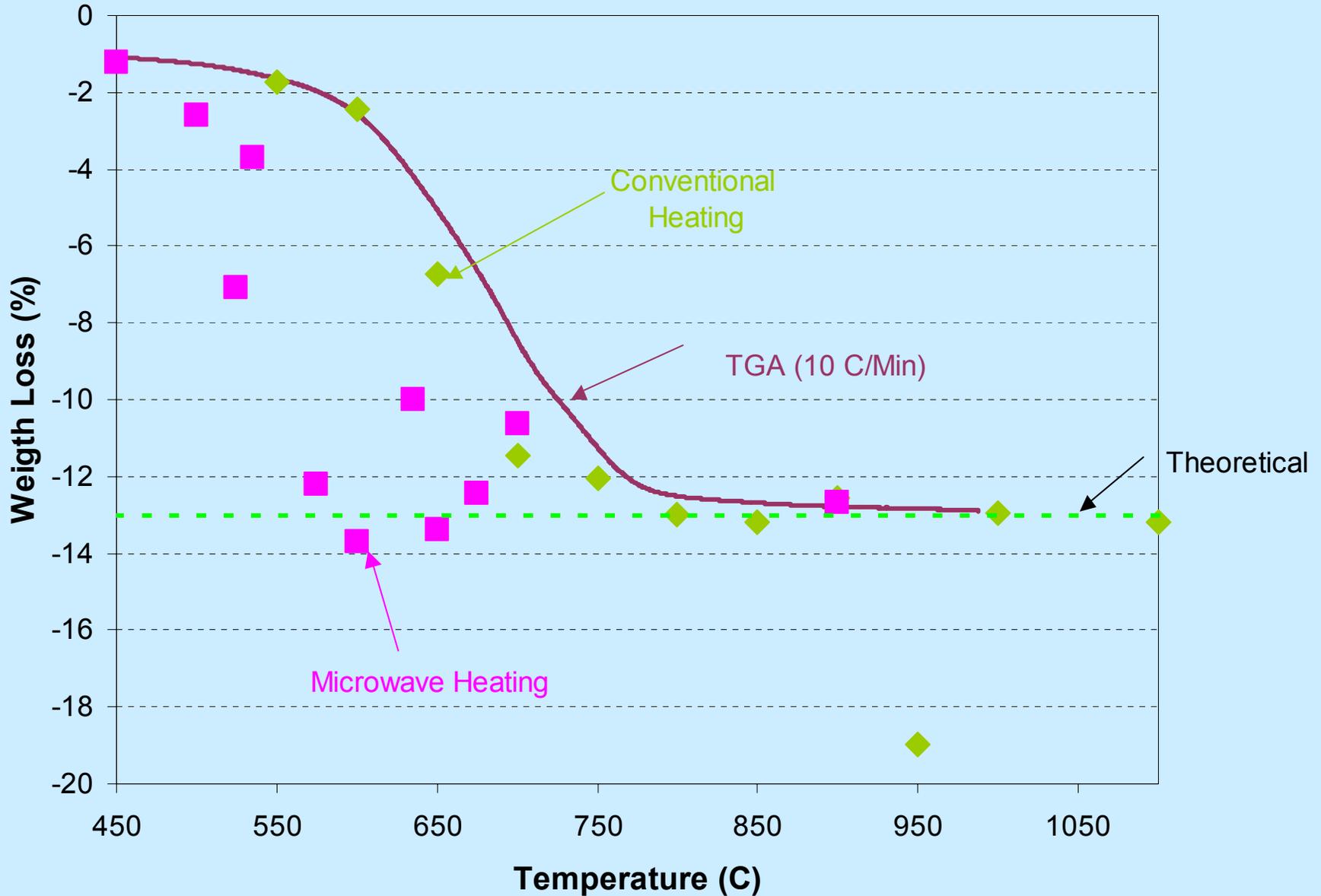
X-ray Diffraction Patterns of Microwave Products

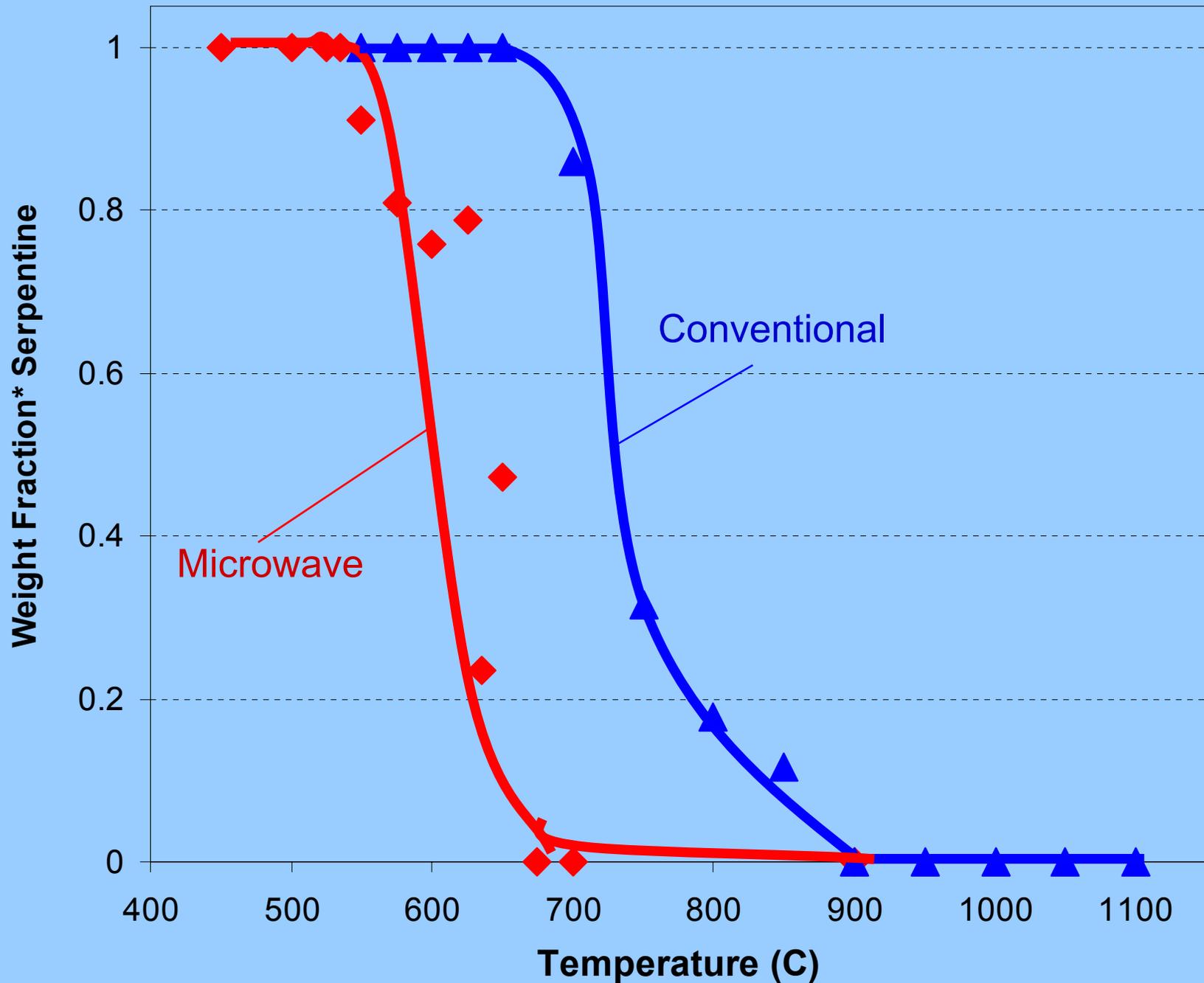






Comparison: Microwave Firing, Conventional Heating and TGA





* BASED ON PERCENT CRYSTALLINE PHASE

Conclusions

1) For dehydroxylation reaction:



microwave processing lowers threshold by $\sim 100^\circ\text{C}$.

2) Products contain unknown amorphous phase(s).

3) Question: Does microwave dehydroxylation prepare surfaces for carbonation reactions



Use of a Microwave Digester as a Reaction Vessel

Initial Conditions

0.5 gms of solid

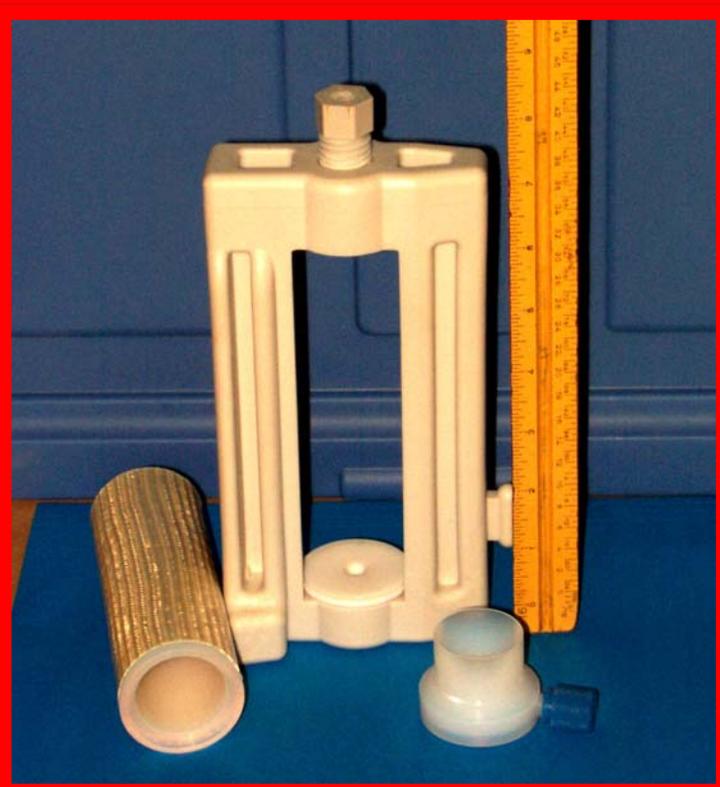
10 mL Concentrated HCL

In Sealed Container

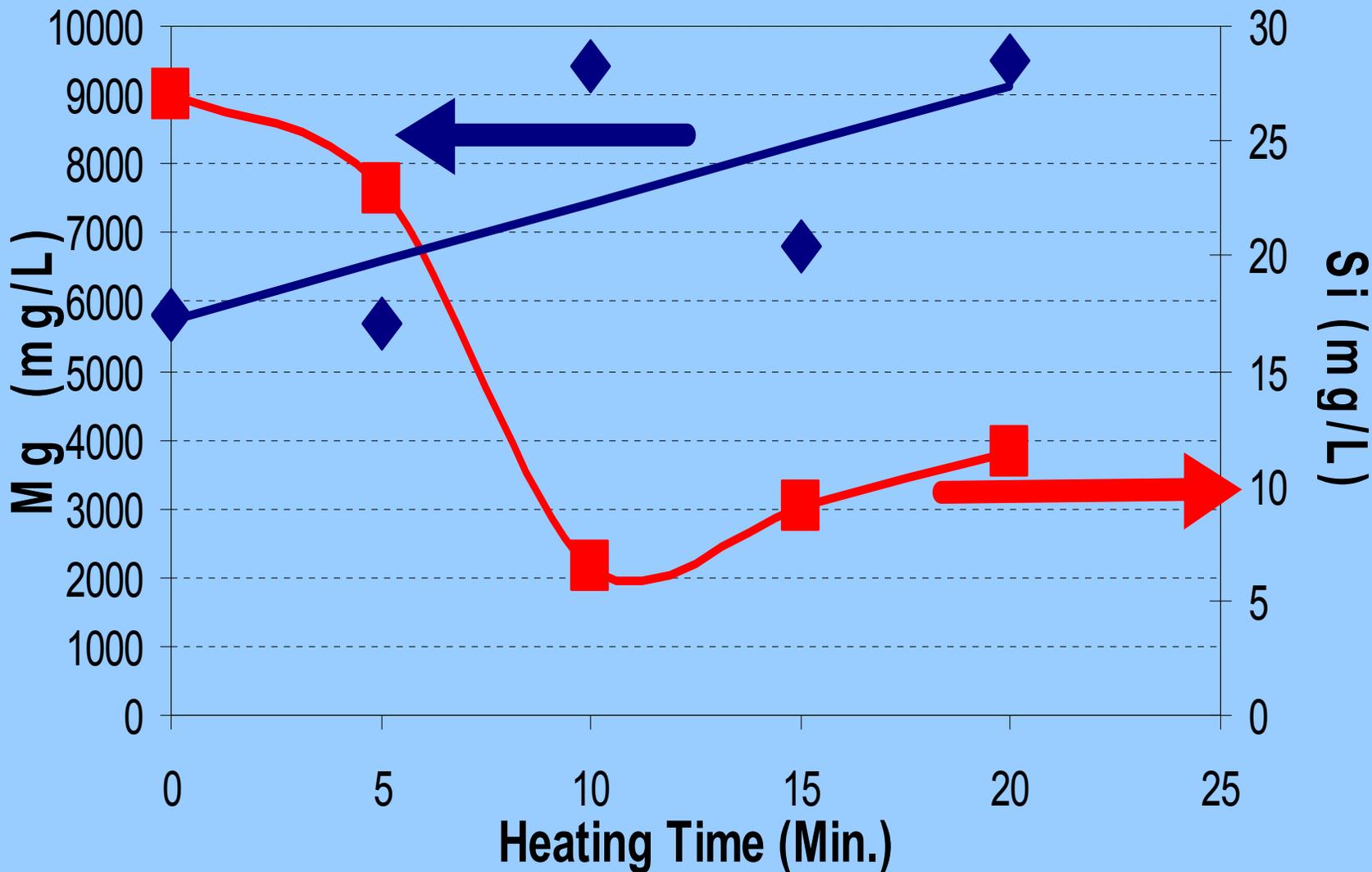
Heat at 600 watts for designated time

Microwave Digester

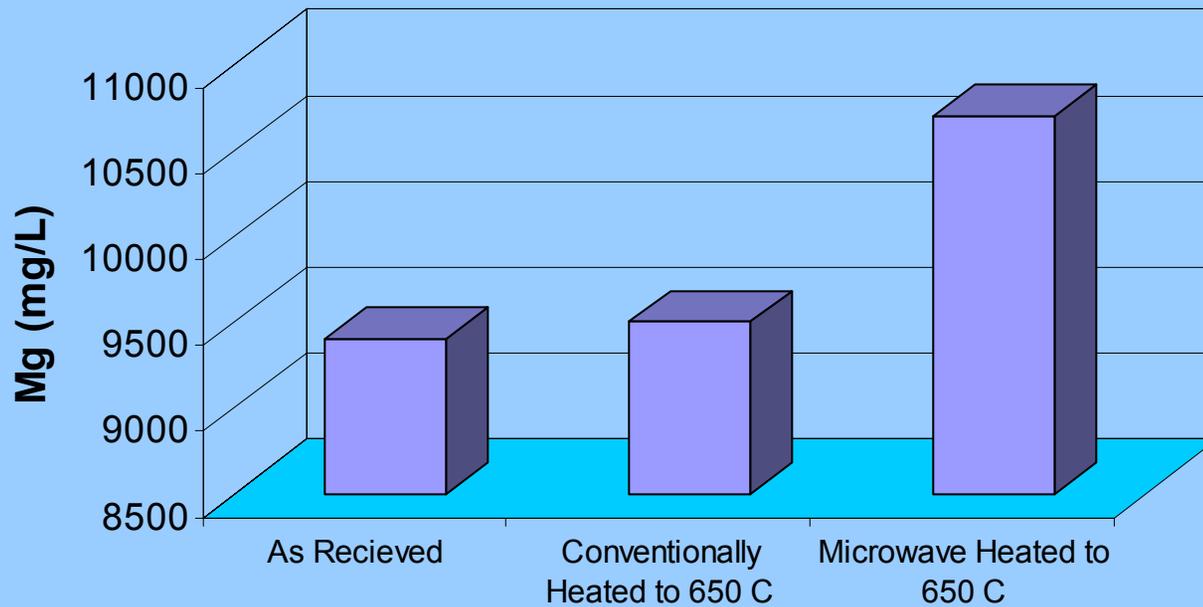
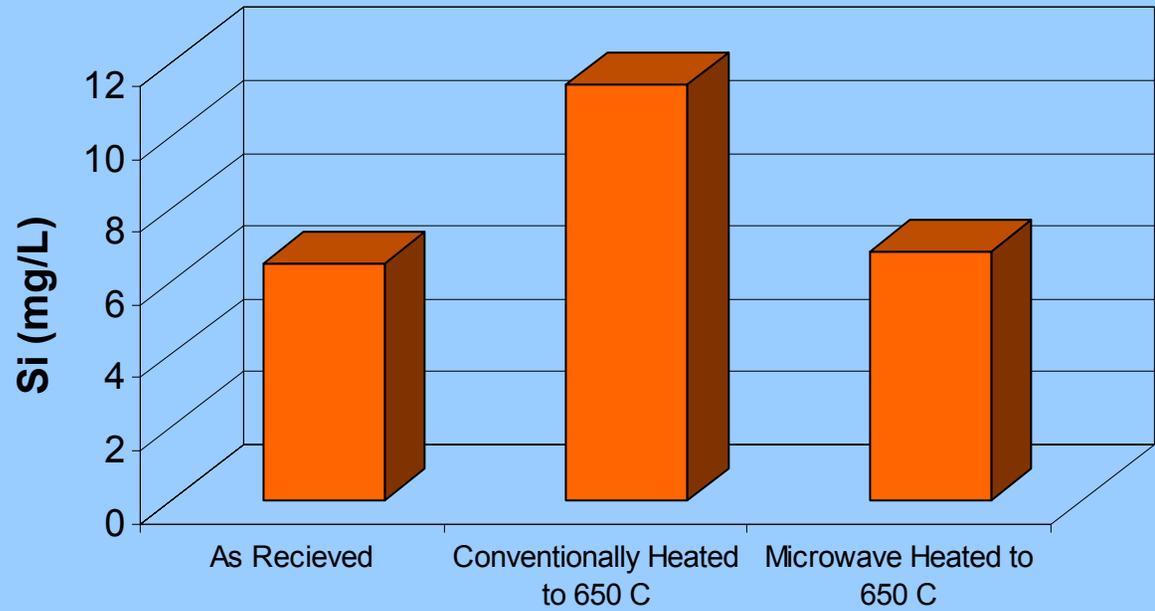




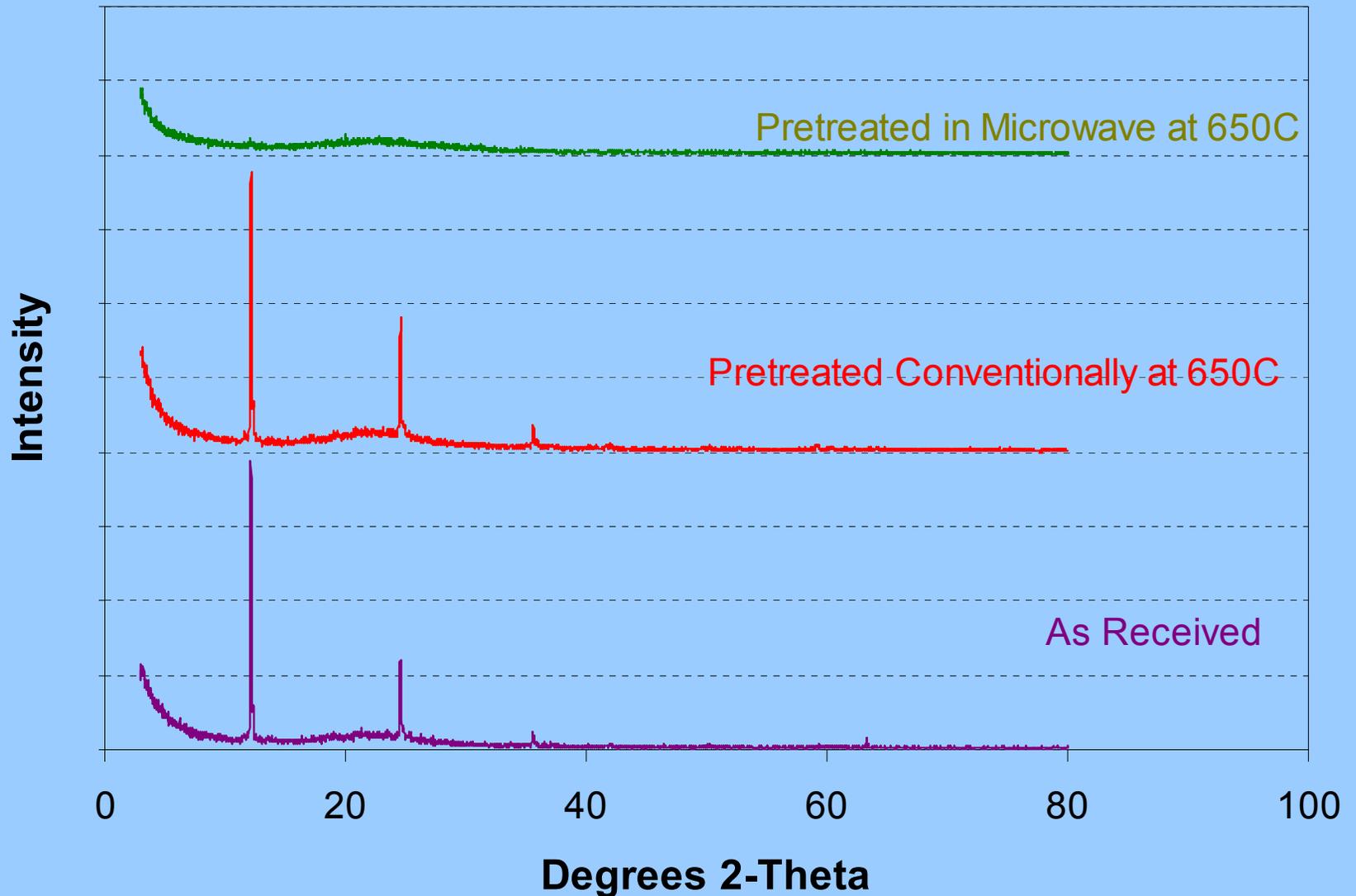
Concentrations after Treatment in the Microwave with Concentrated HCl



Treated with
Microwave
Hydrothermal
for 10 minutes
in concentrated HCL

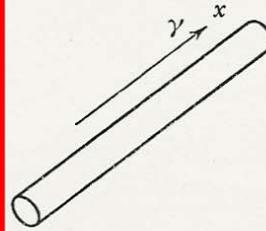


After Being Treated with a Microwave Digester for 10 minutes
in Concentrated HCL

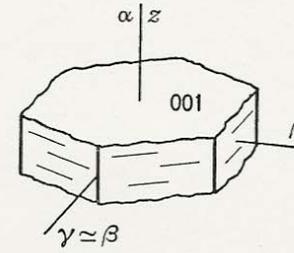


Structure of Serpentine Materials

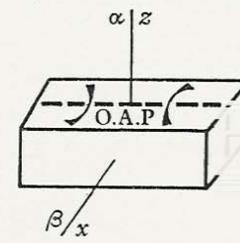
MONOCLINIC (-)



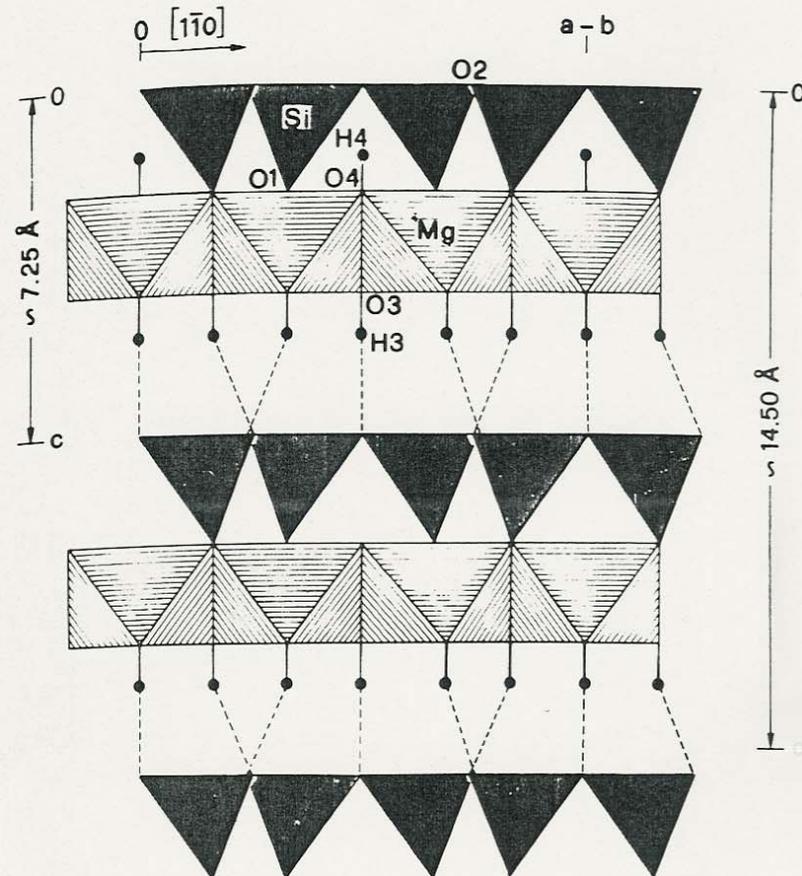
Chrysotile

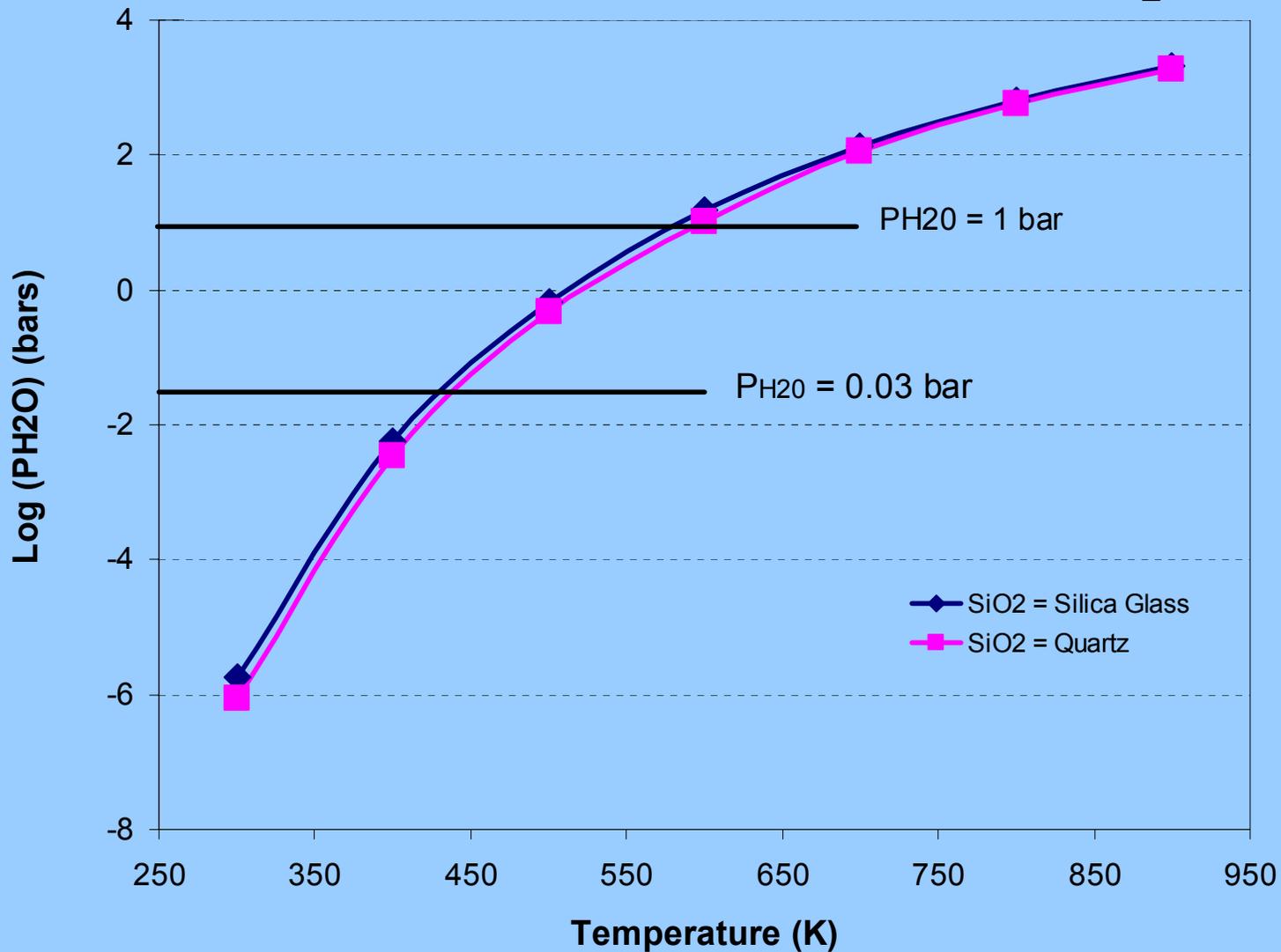


Lizardite



Antigorite





Equilibrium Calculations

