Temperature excursions during controlled regeneration of diesel particulate filters

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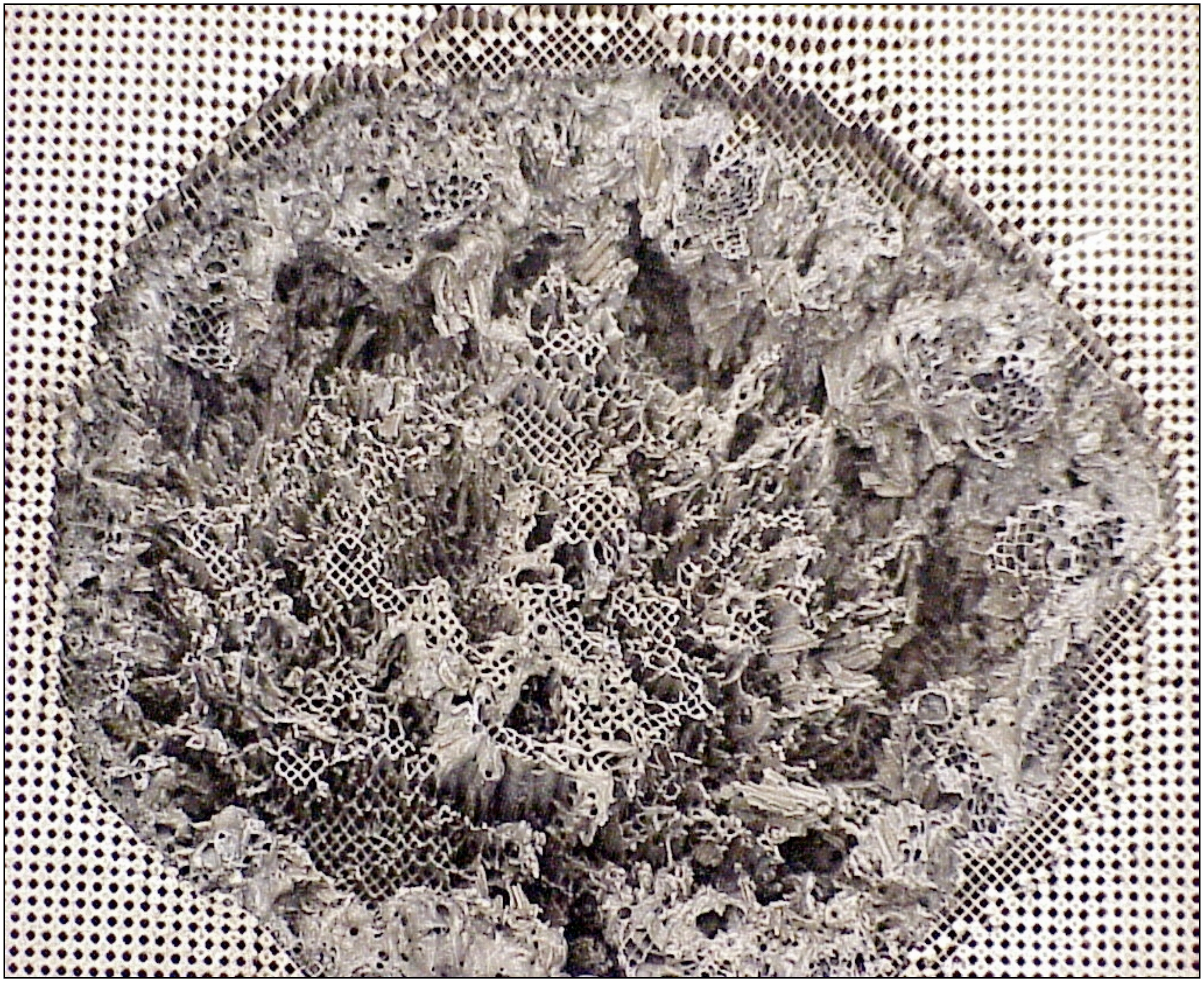
Hot spots may melt DPF walls and destroy it

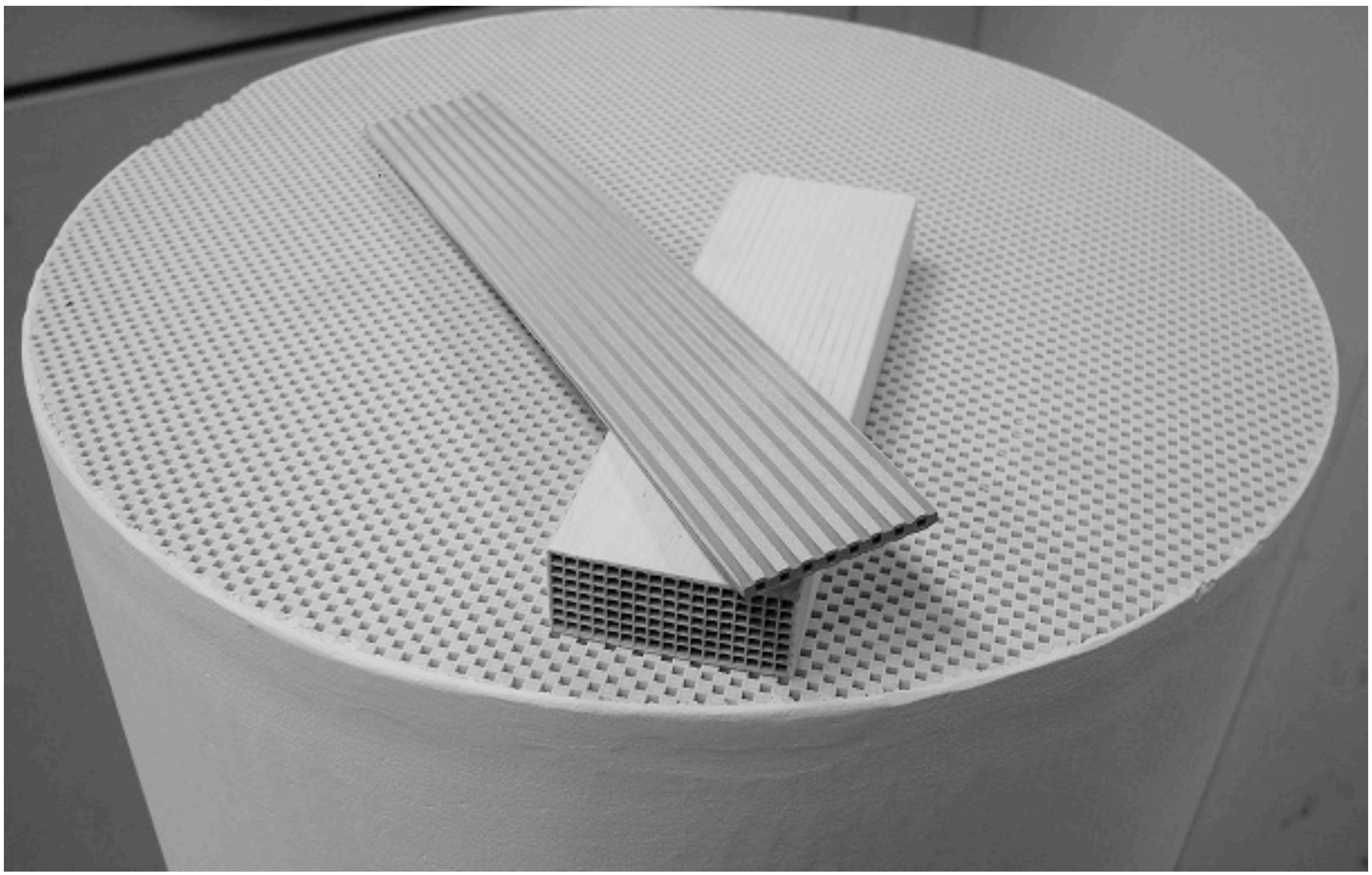


Research goals

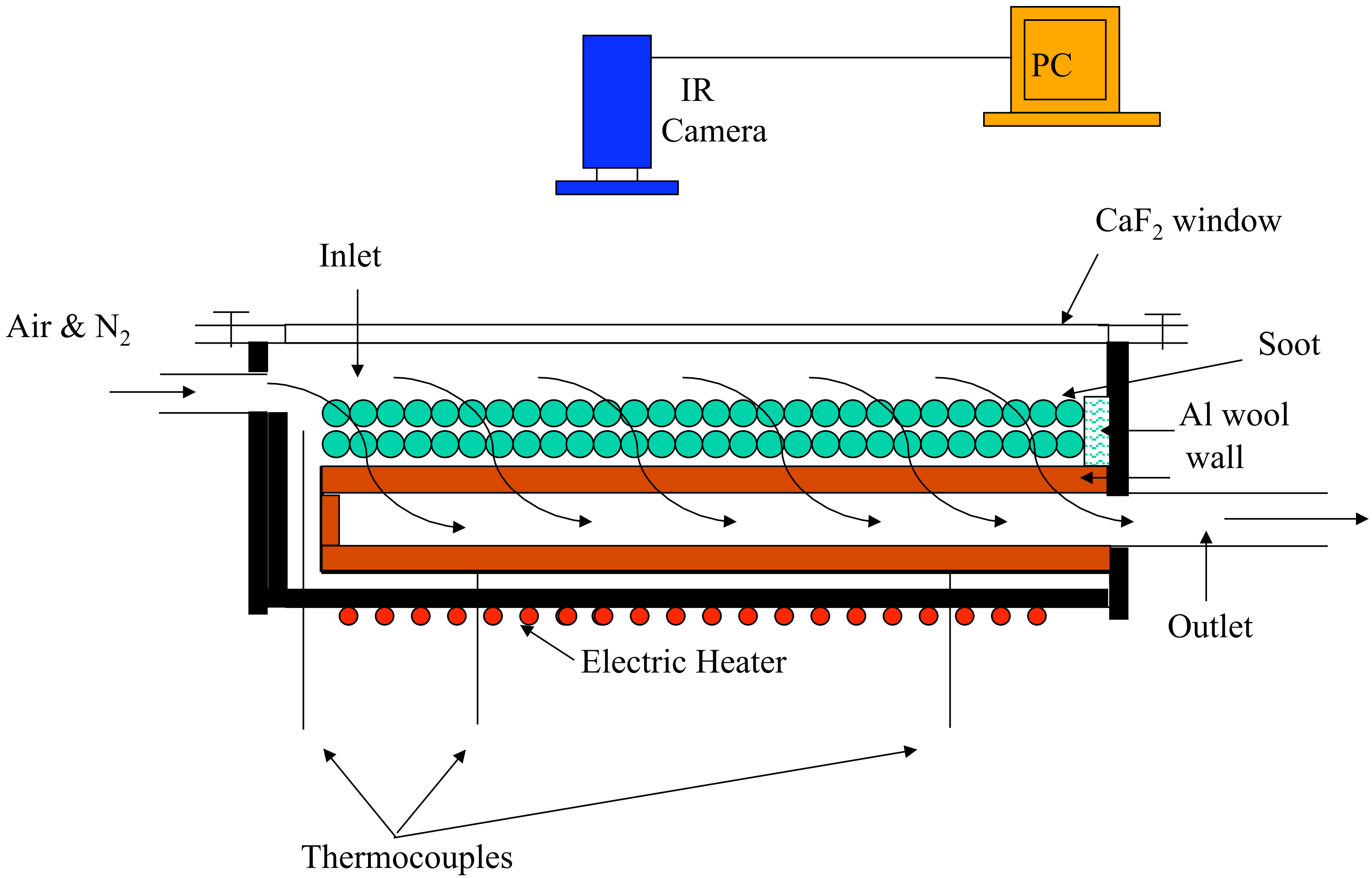
Gain qualitative understanding of the impact of regeneration procedure and operating conditions on temperature rise

Gain understanding of the impact of sudden changes in feed temperature on temperature rise

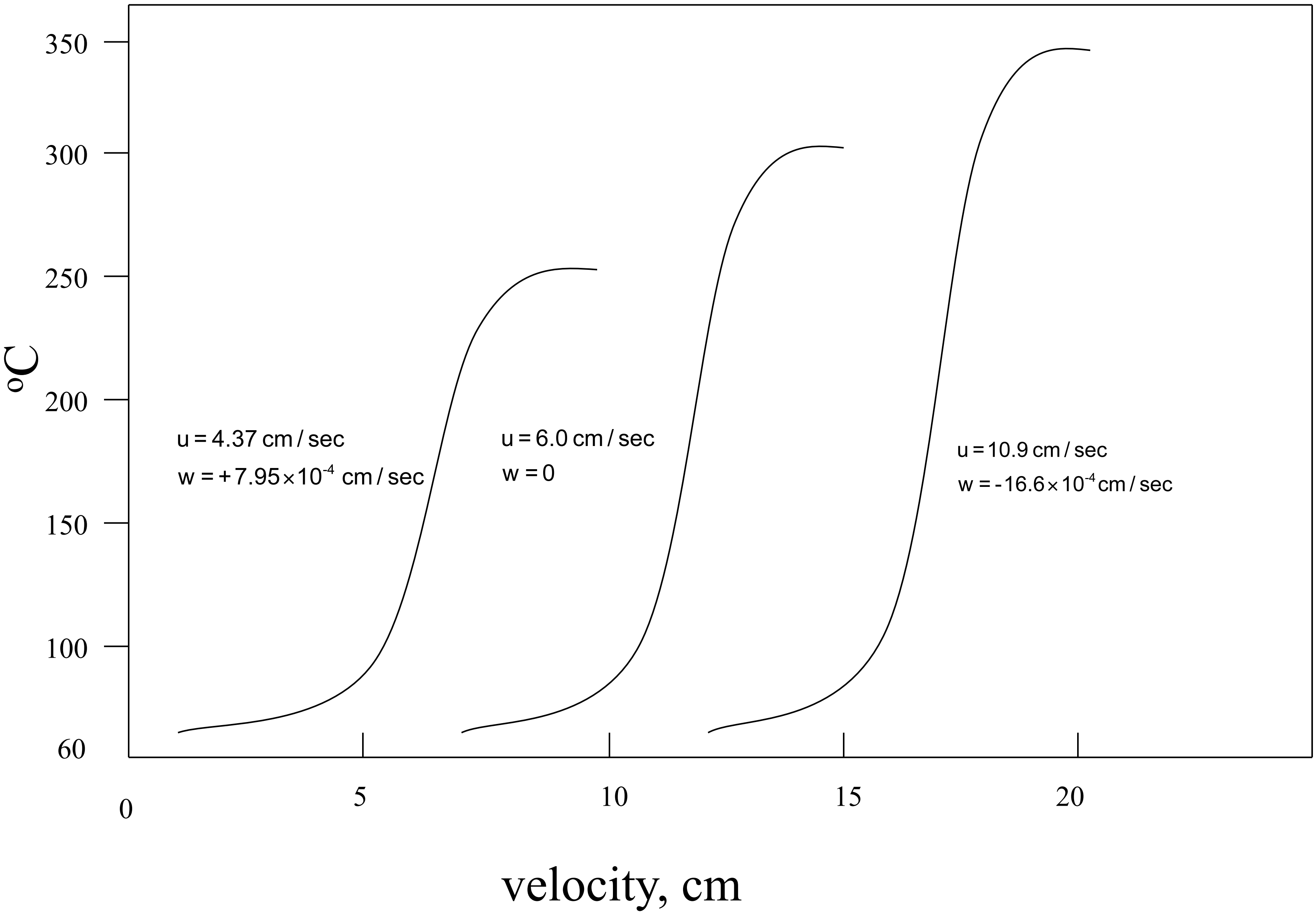
Single and multiple layer DPF used in experiments



Experimental setup using single layer DPF

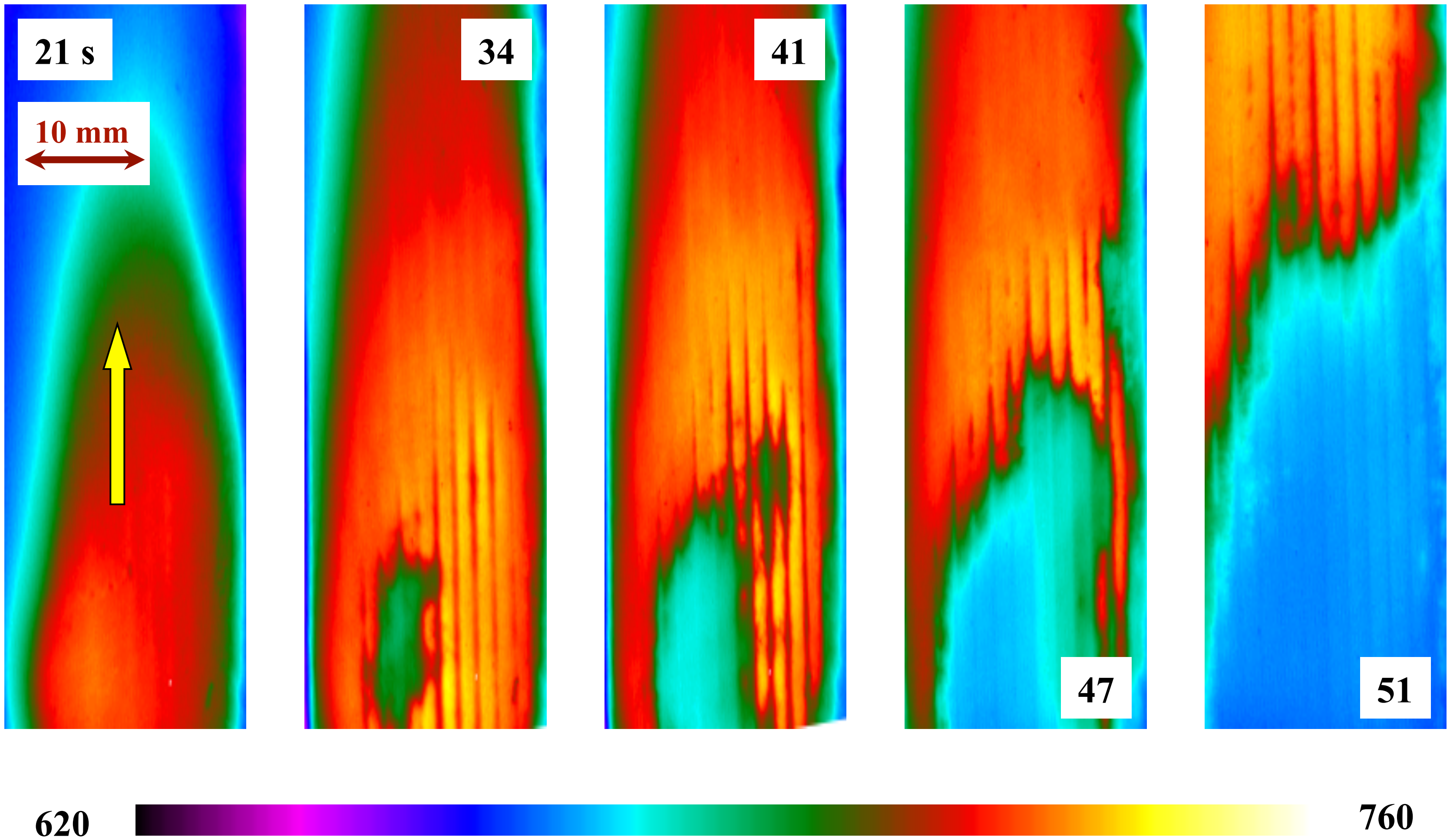


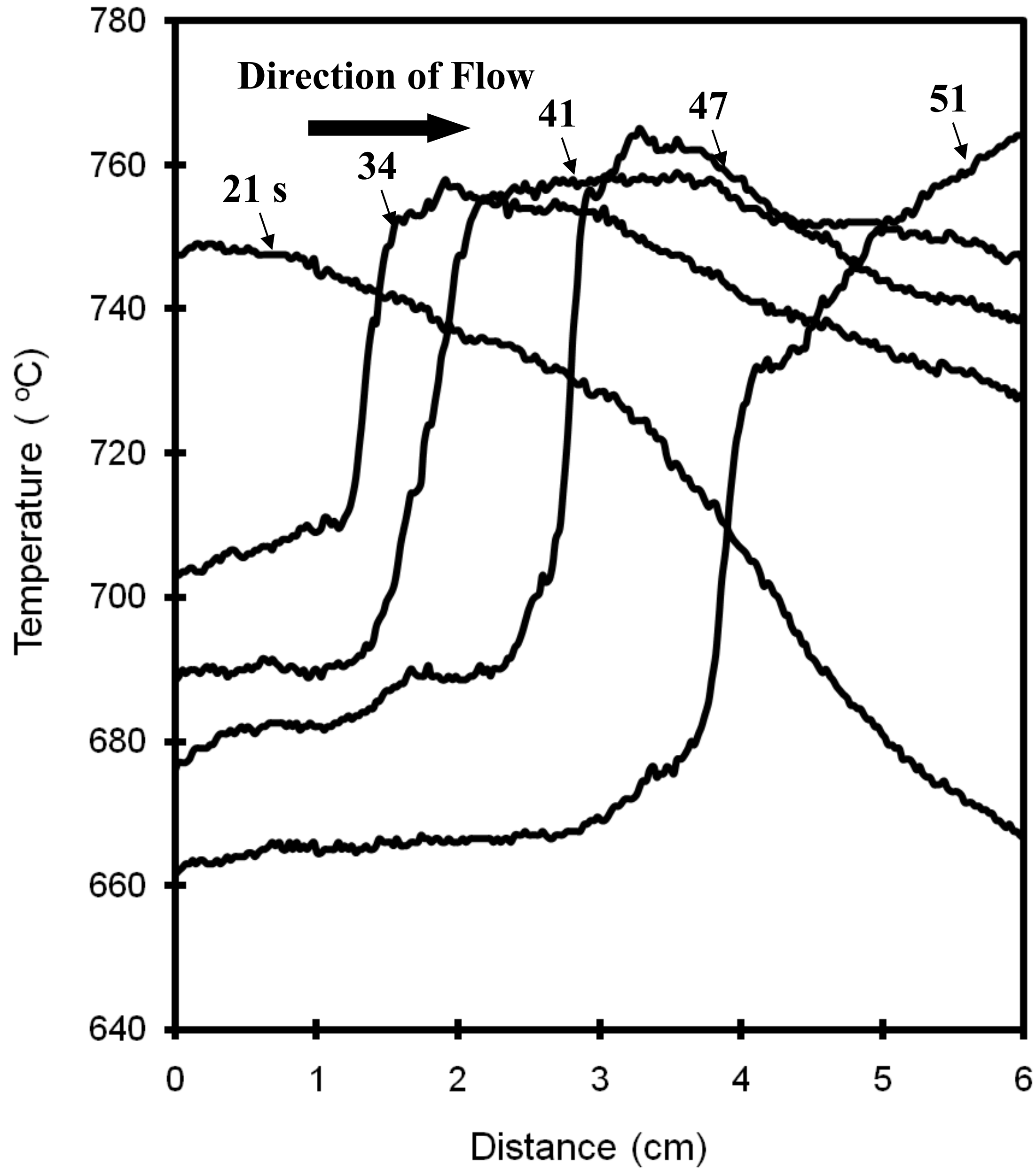
Impact of flow direction on front temperature



$T_i = 620^oC$, L=10 g/L, O_2 = 15v. % v=5 cm/s

Downstream moving front

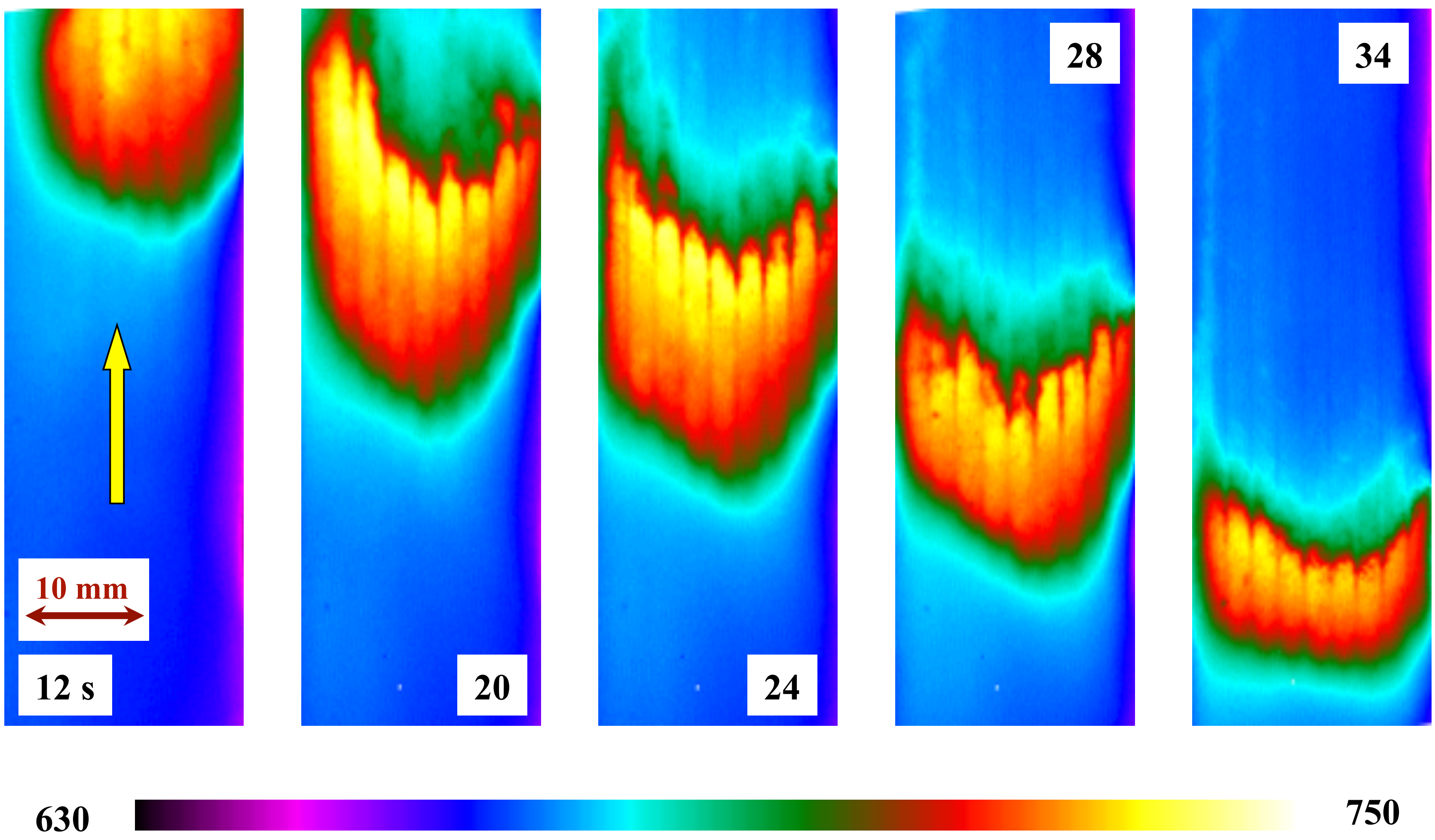


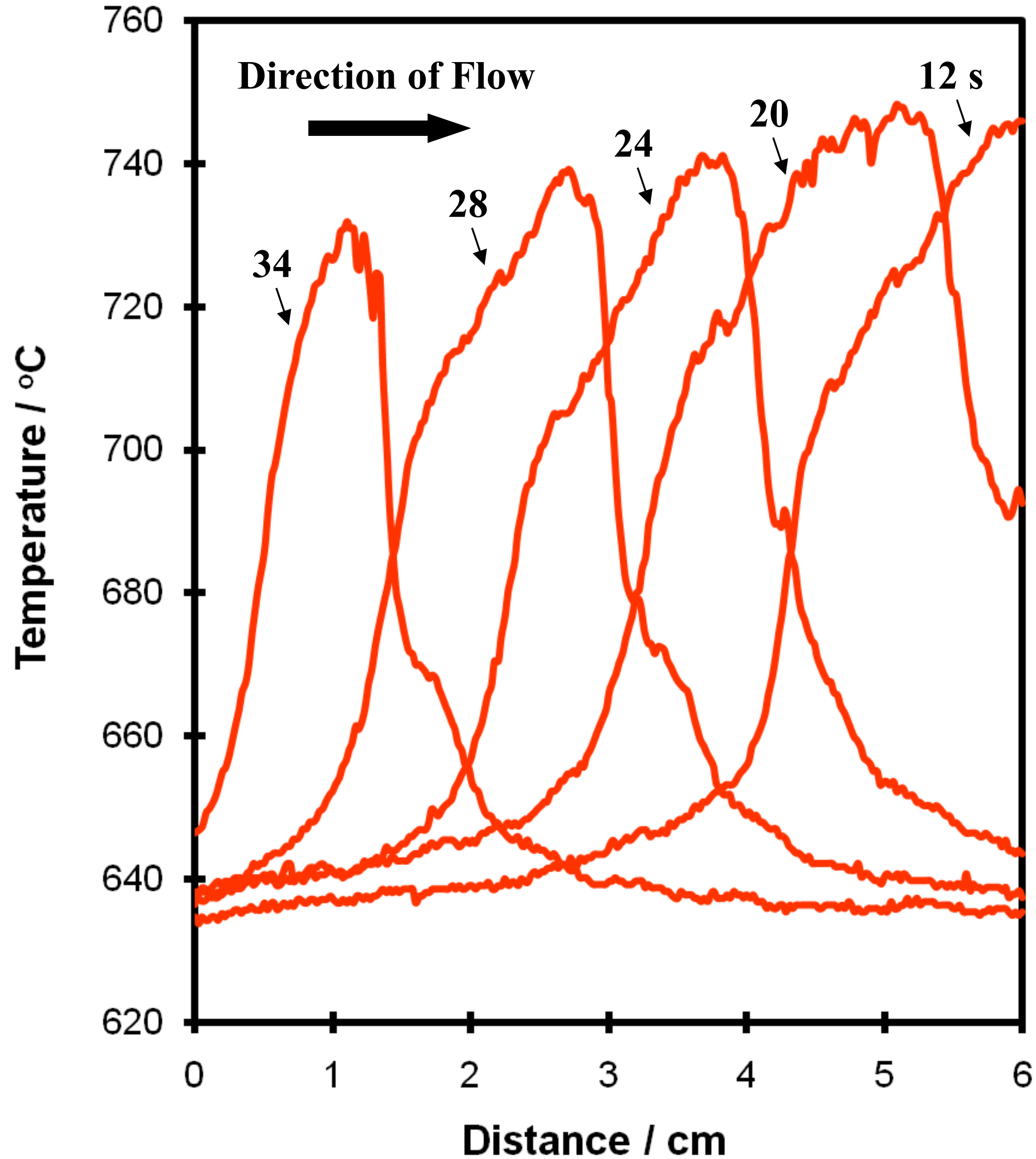


Direction of Flow
21 s
34
41
47
51
Temperature (°C)
780
760
740
720
700
680
660
640
0
1
2
3
4
5
6
Distance (cm)

$T_i = 620^oC$, L=10 g/L, O_2 = 10v. %   v=12 cm/s

Upstream moving front

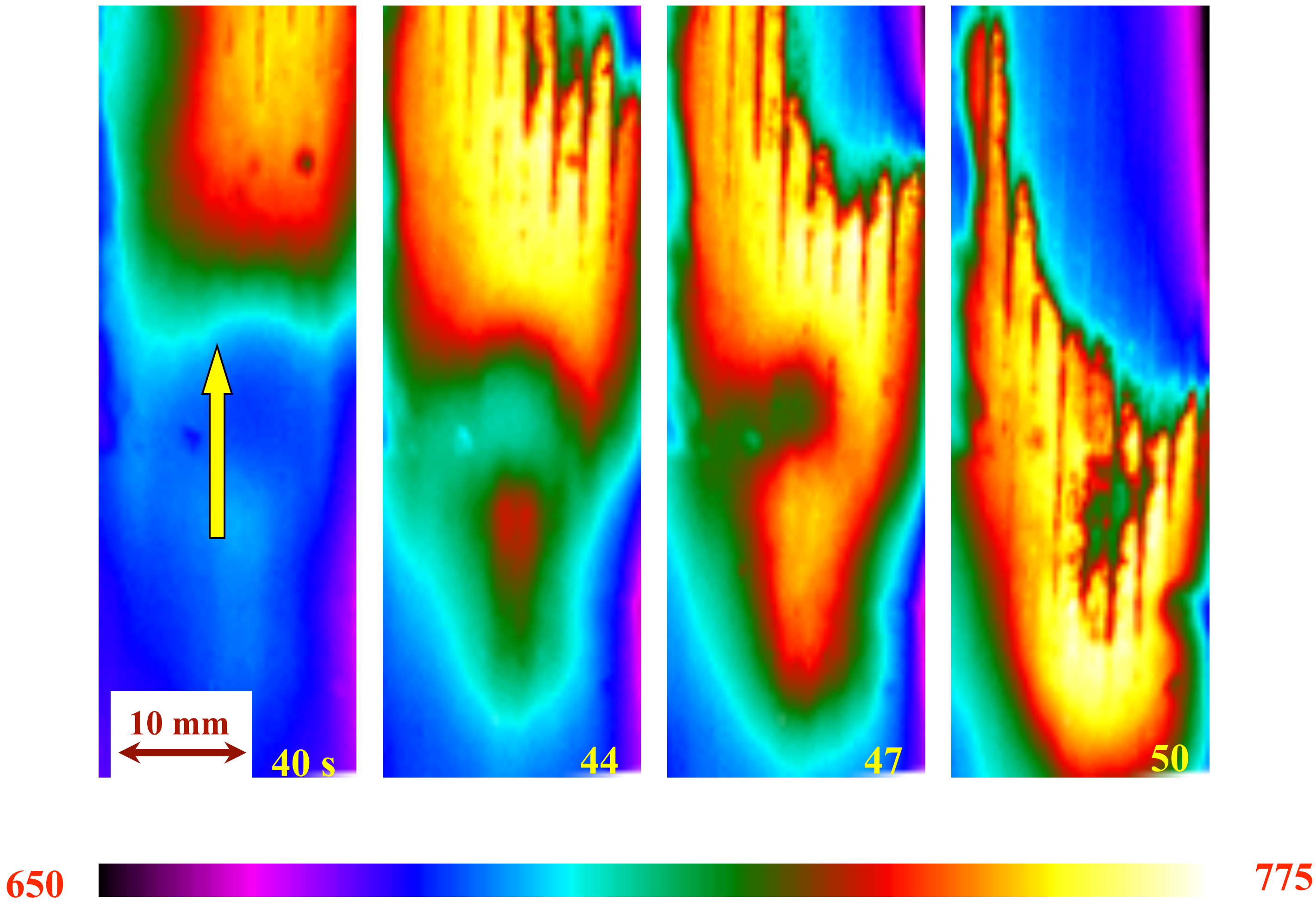




Direction of Flow
12 s
20
24
28
34
Temperature / °C
Distance / cm
760
740
720
700
680
660
640
620
0
1
2
3
4
5
6

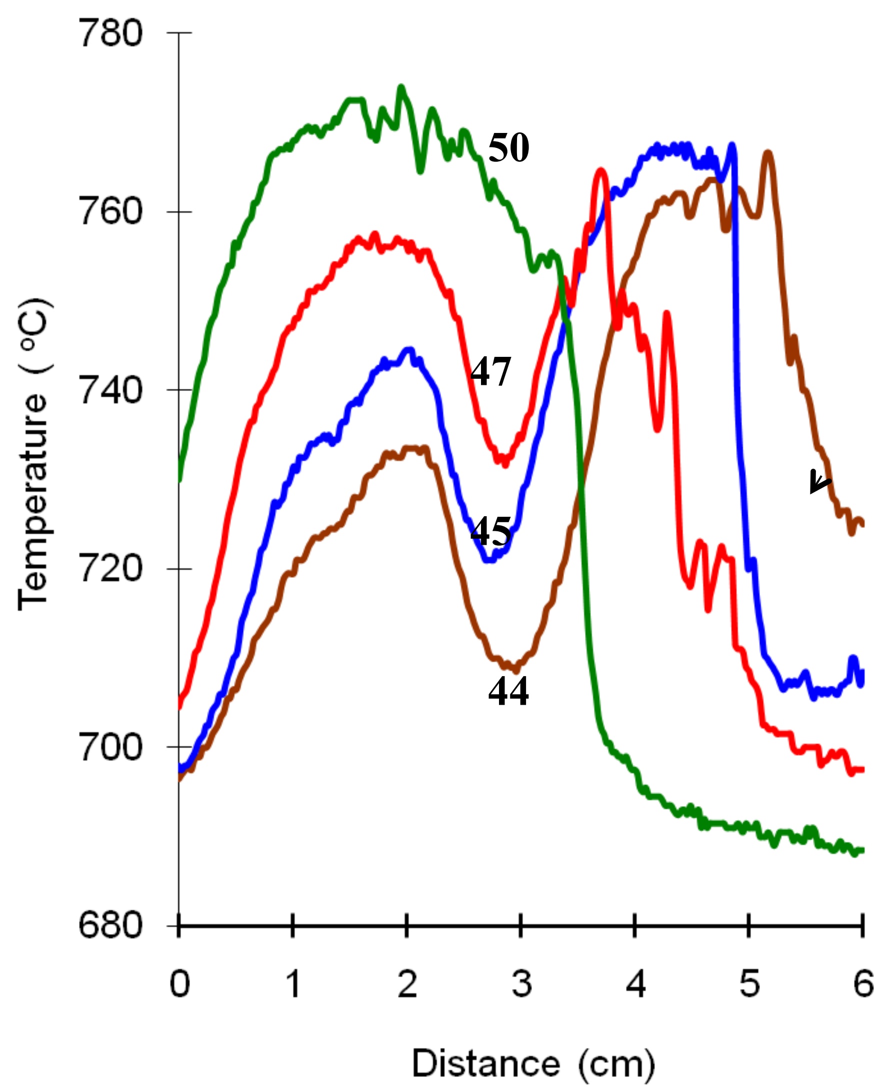
T_i = 635°C, L=10 g/L, O_2 = 15v. % v=12 cm/s

Upstream motion, Two ignition points

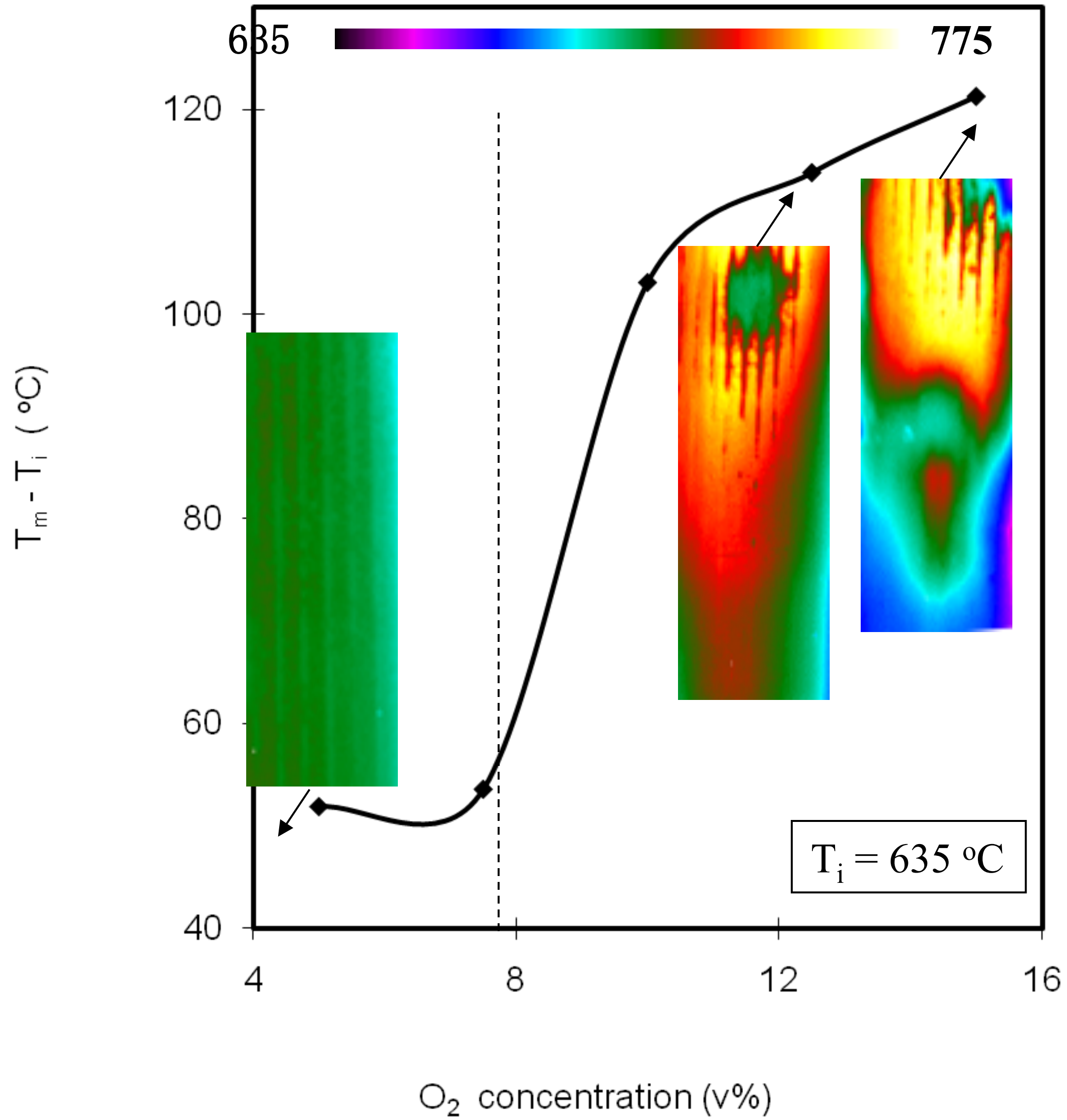


Temporal temperature profiles

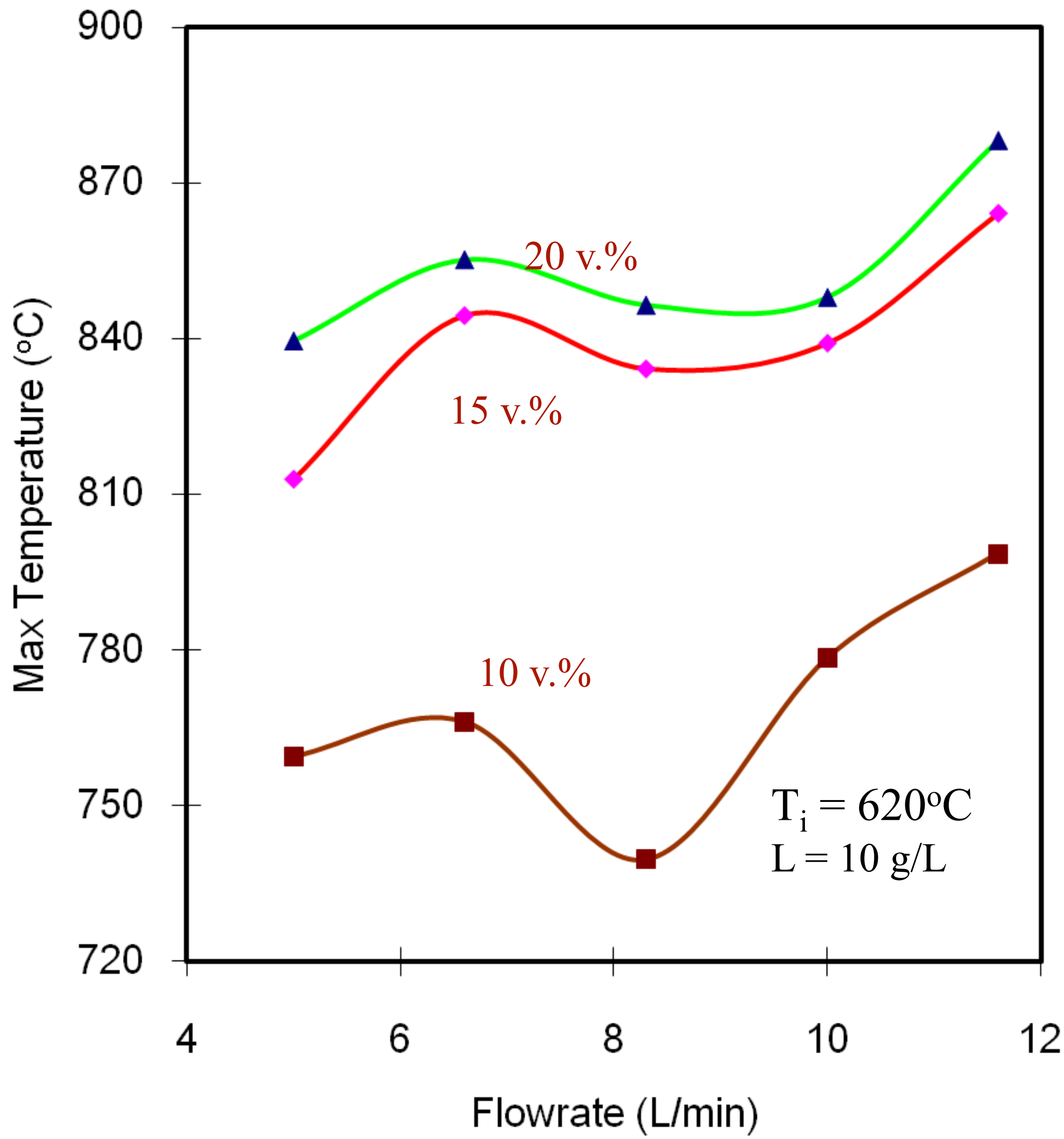
T_i = 635°C, L=10 g/L, O_2 = 15v. %



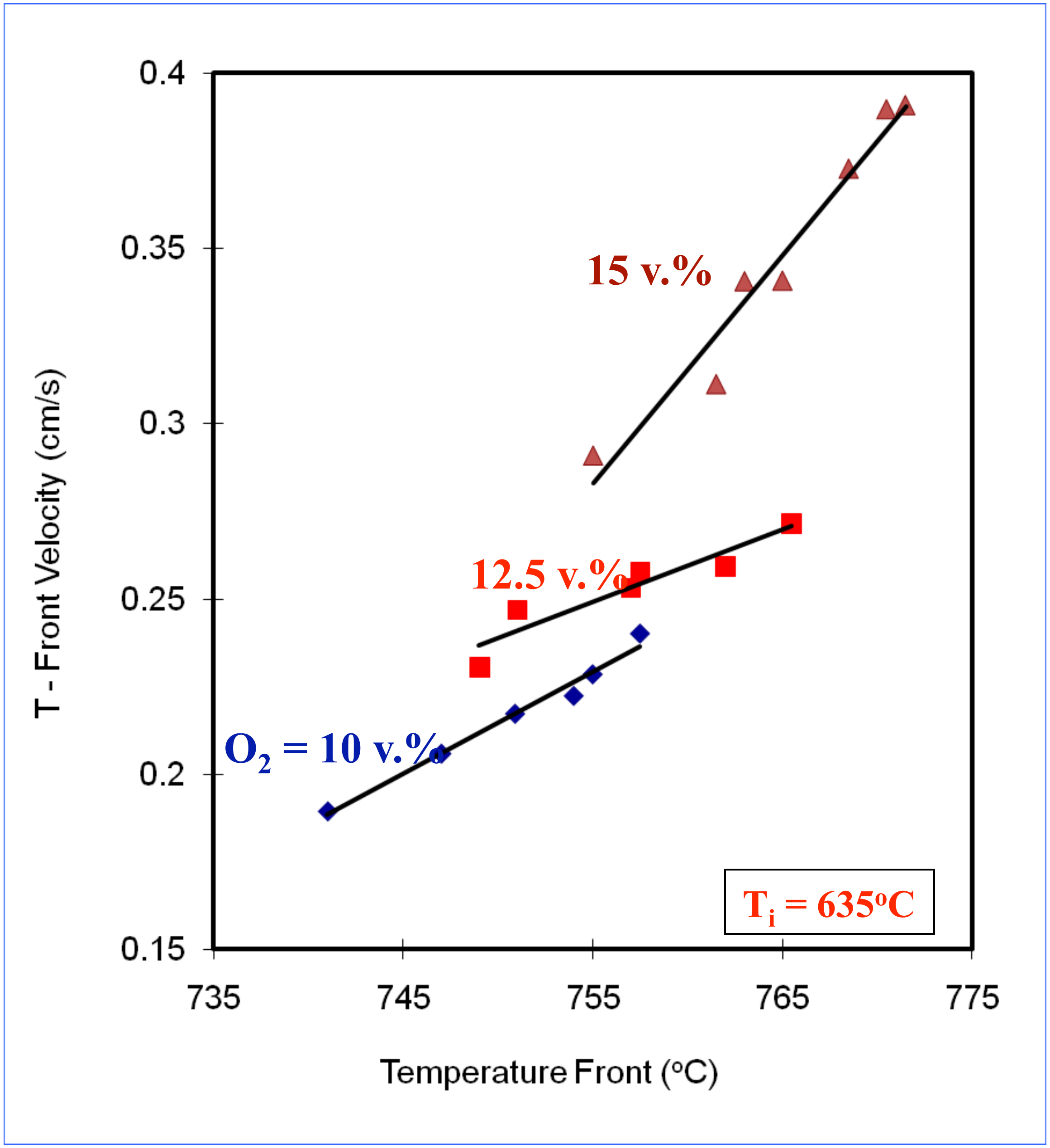
Dependence of T rise on O_2, L=10 g/L, v=12 cm/s



Impact of flow rate on front temperature and velocity

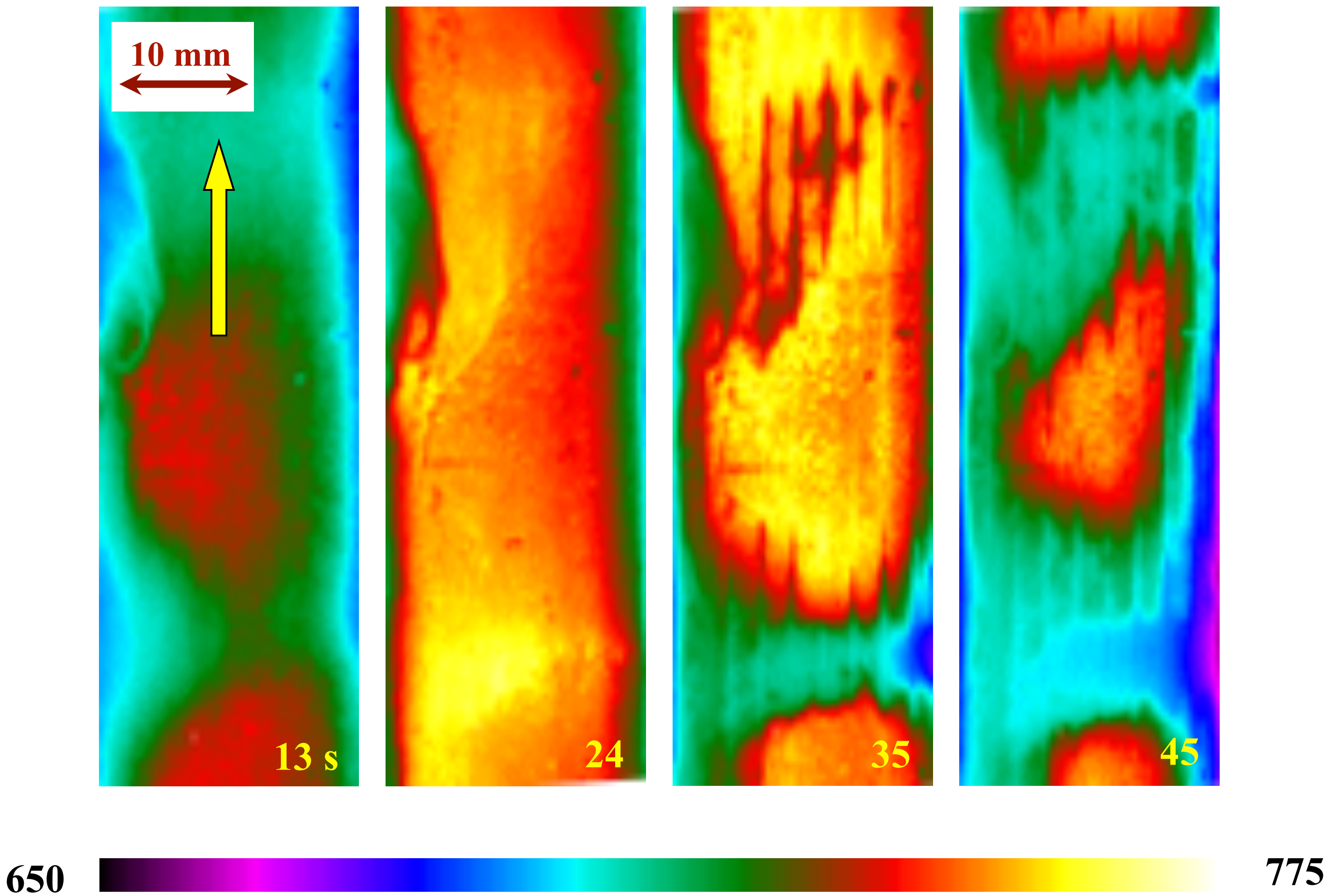


Front temperature and velocity are not constant



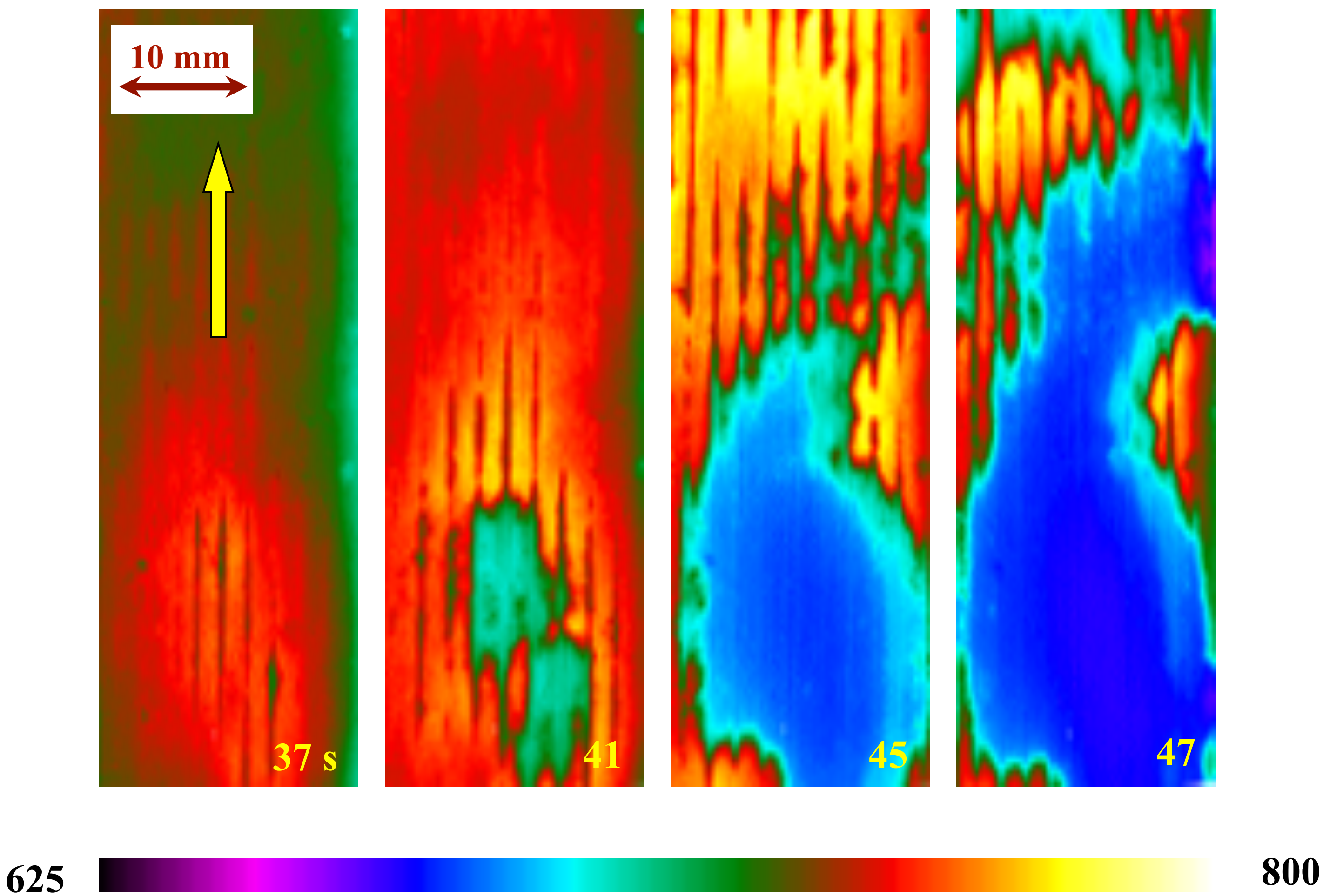
L=20 g/L, T_i = 635°C, O_2 = 7.5v. %, v=12 cm/s

Two ignition points, downwards motion



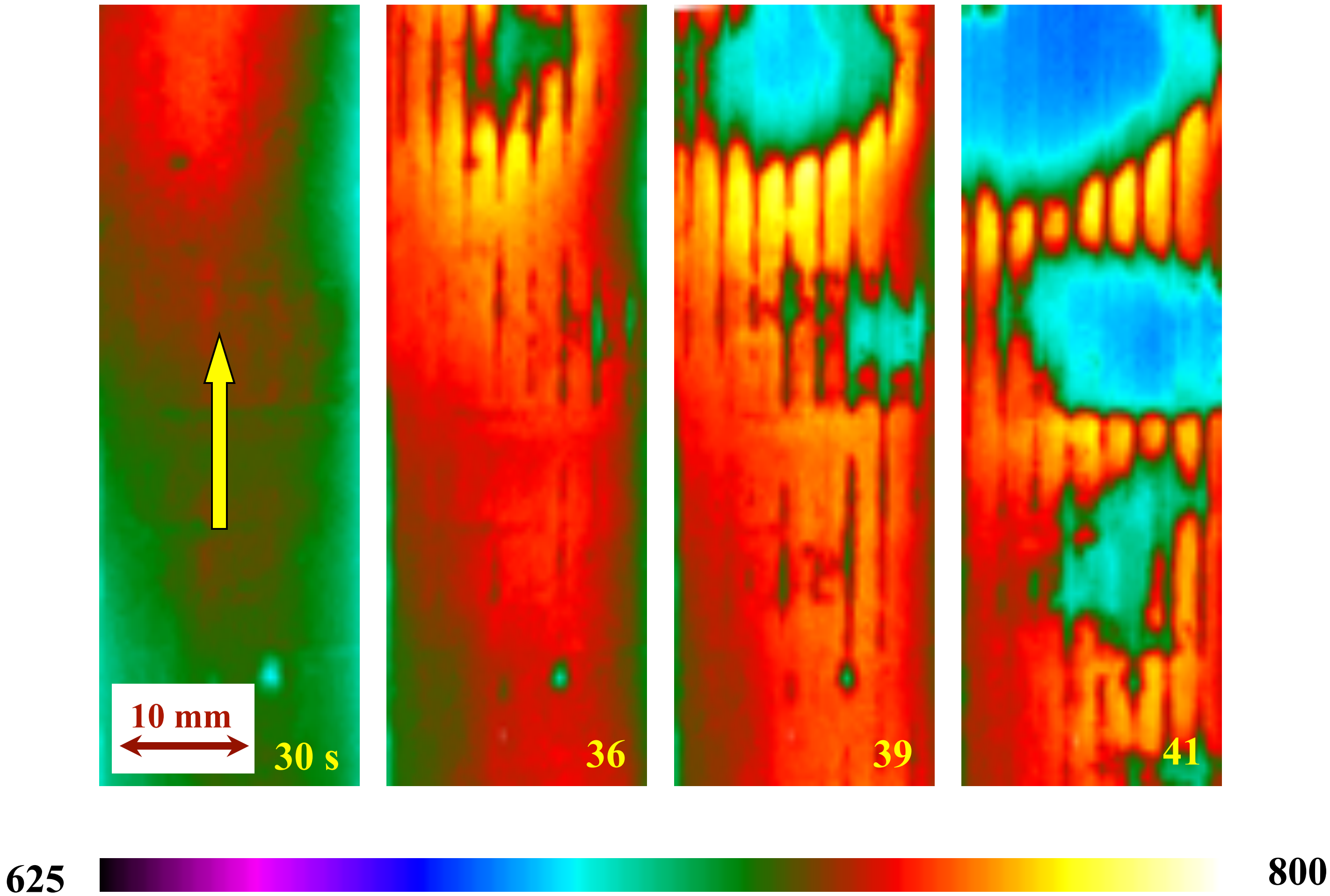
L=20 g/L, T_i = 635°C, O_2 = 10v. % v=12 cm/s

Downstream motion



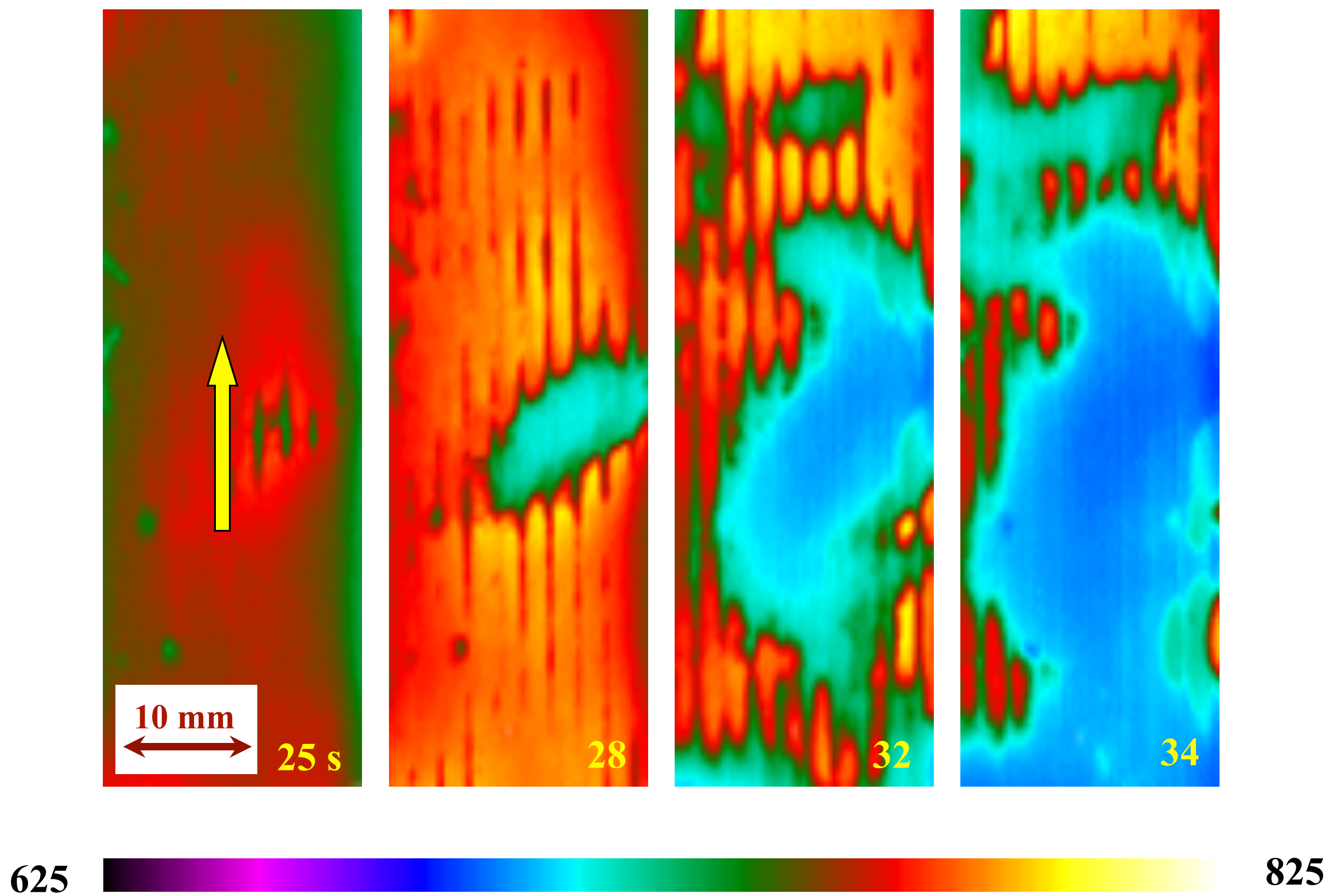
L=20 g/L, T_i = 635°C, O_2 = 12.5v. %, v=12 cm/s

Upstream motion

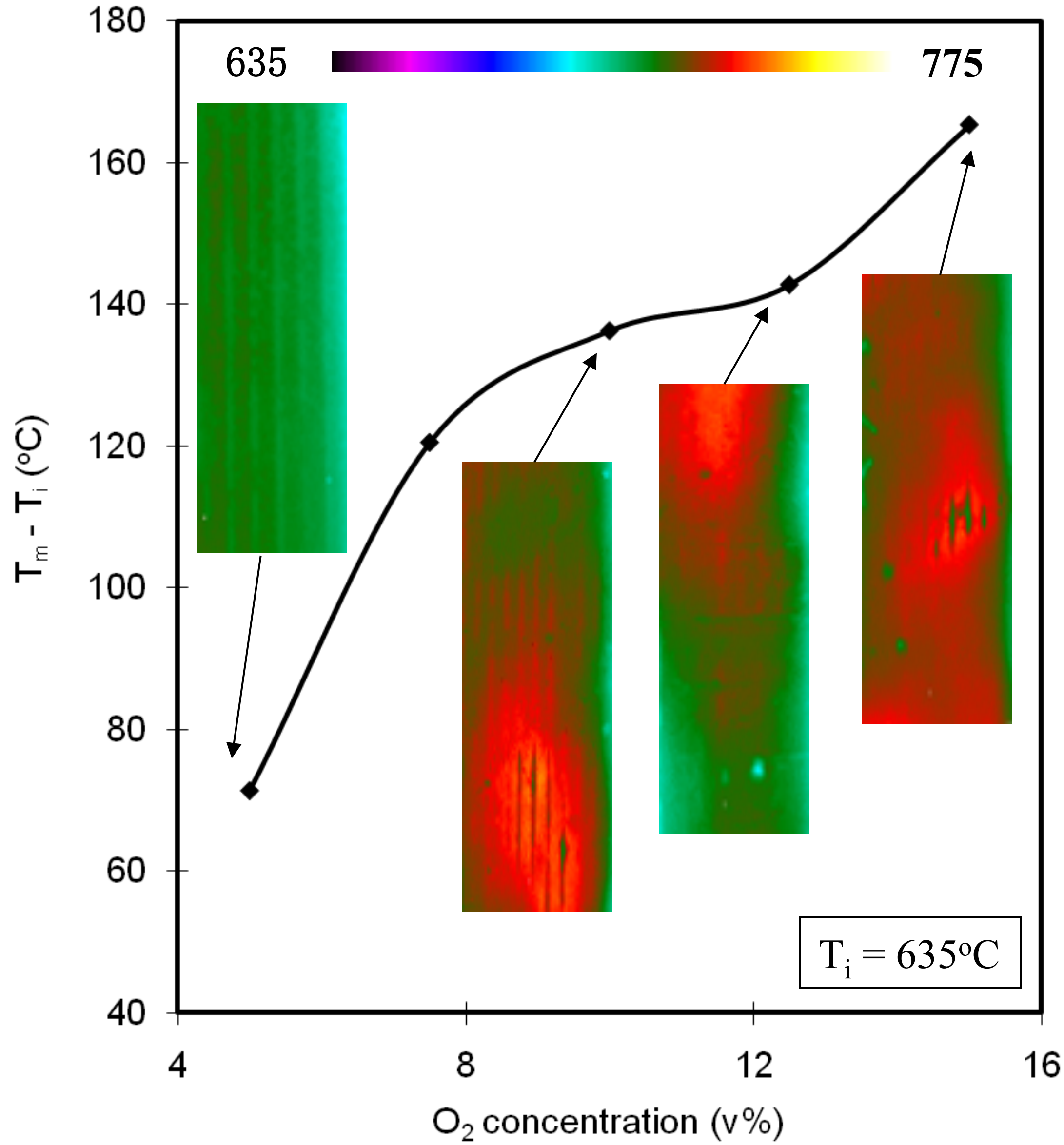


L=20 g/L, T_i = 635°C, O_2 = 15v. % v=12 cm/s

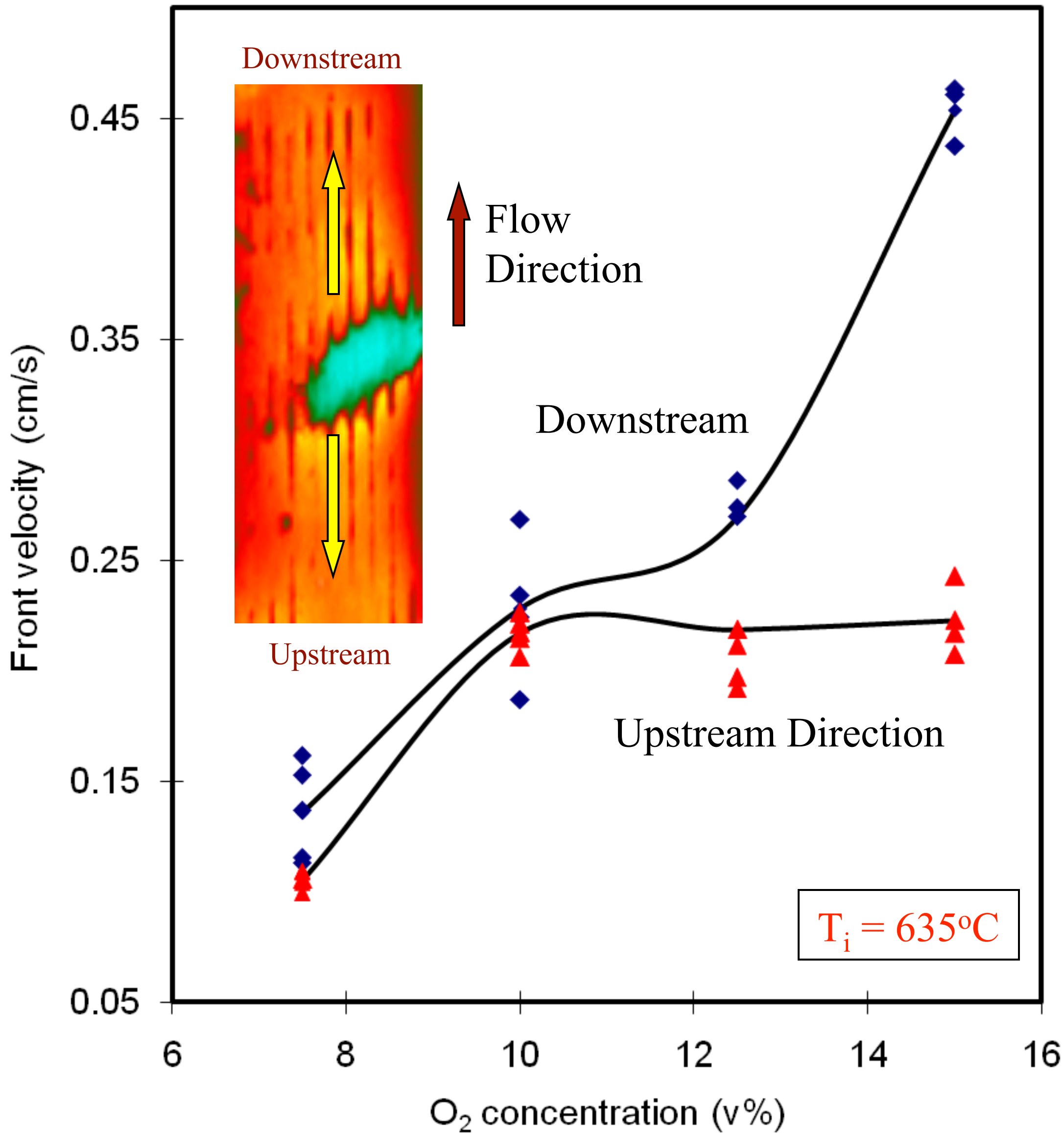
Ignition in center, fronts move in both directions



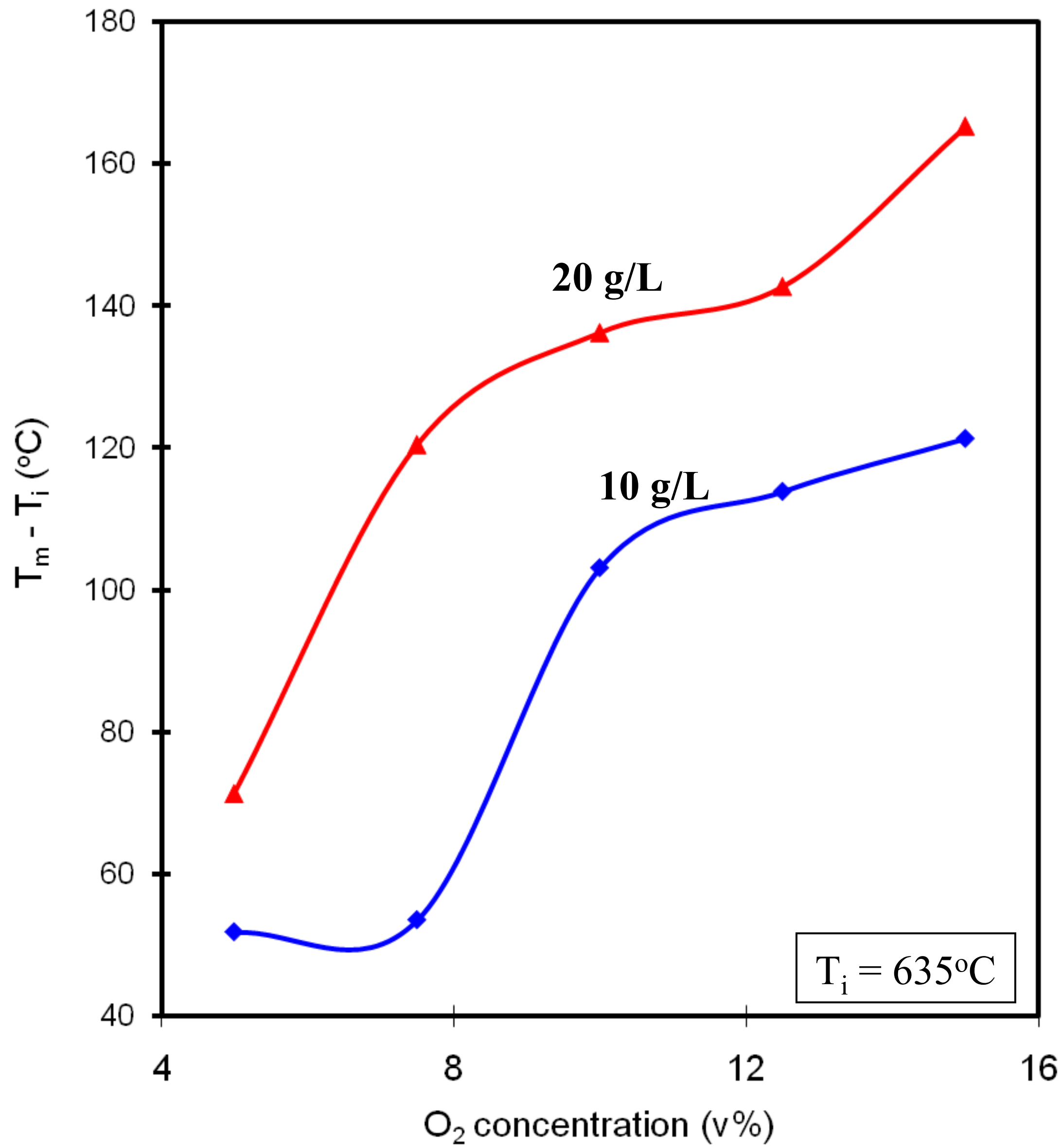
L=20 g/L, v=12 cm/s
Impact of O_2 on combustion



L=20 g/L Impact of O_2 on combustion front velocity

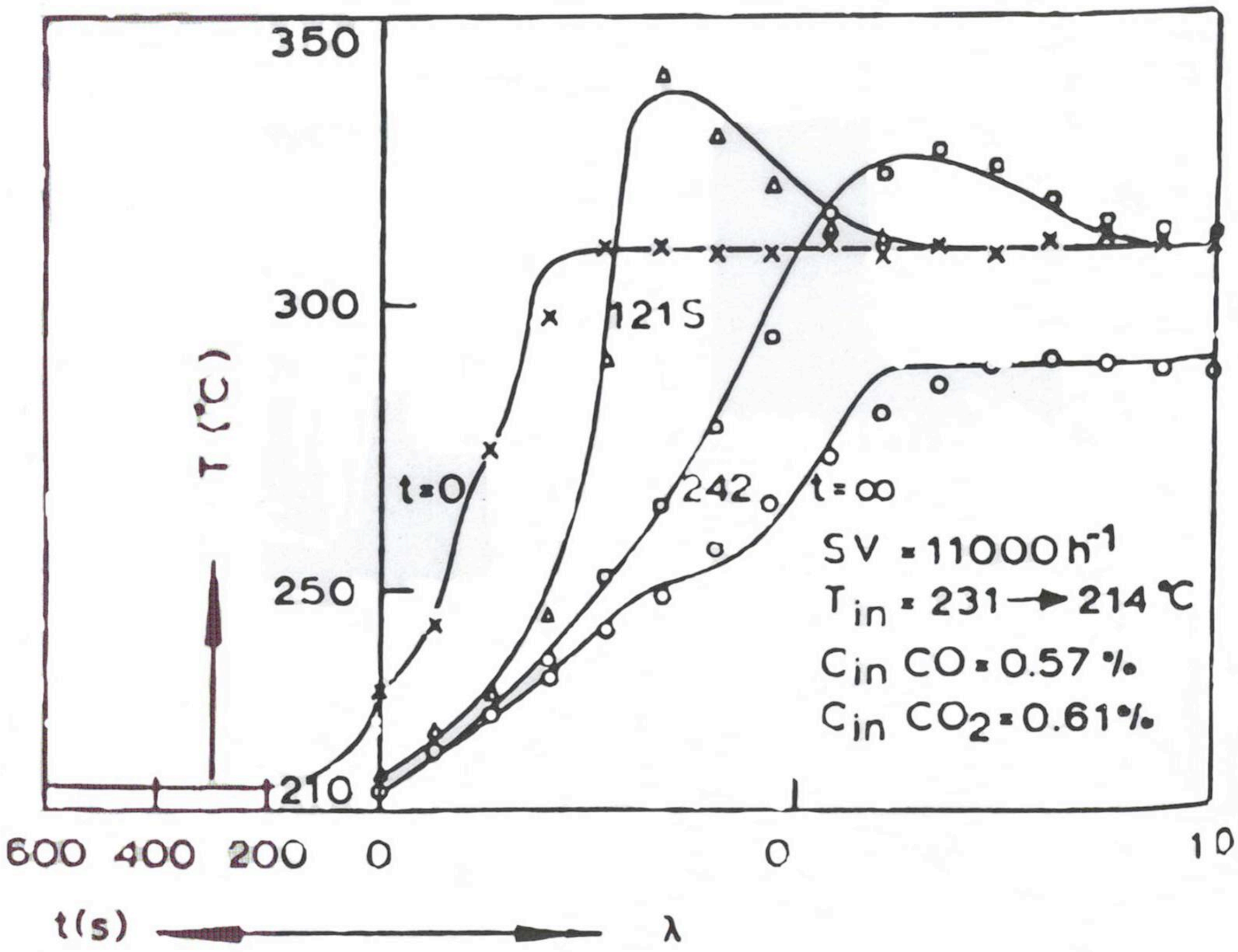


Impact of loading and O_2 on maximum temperature



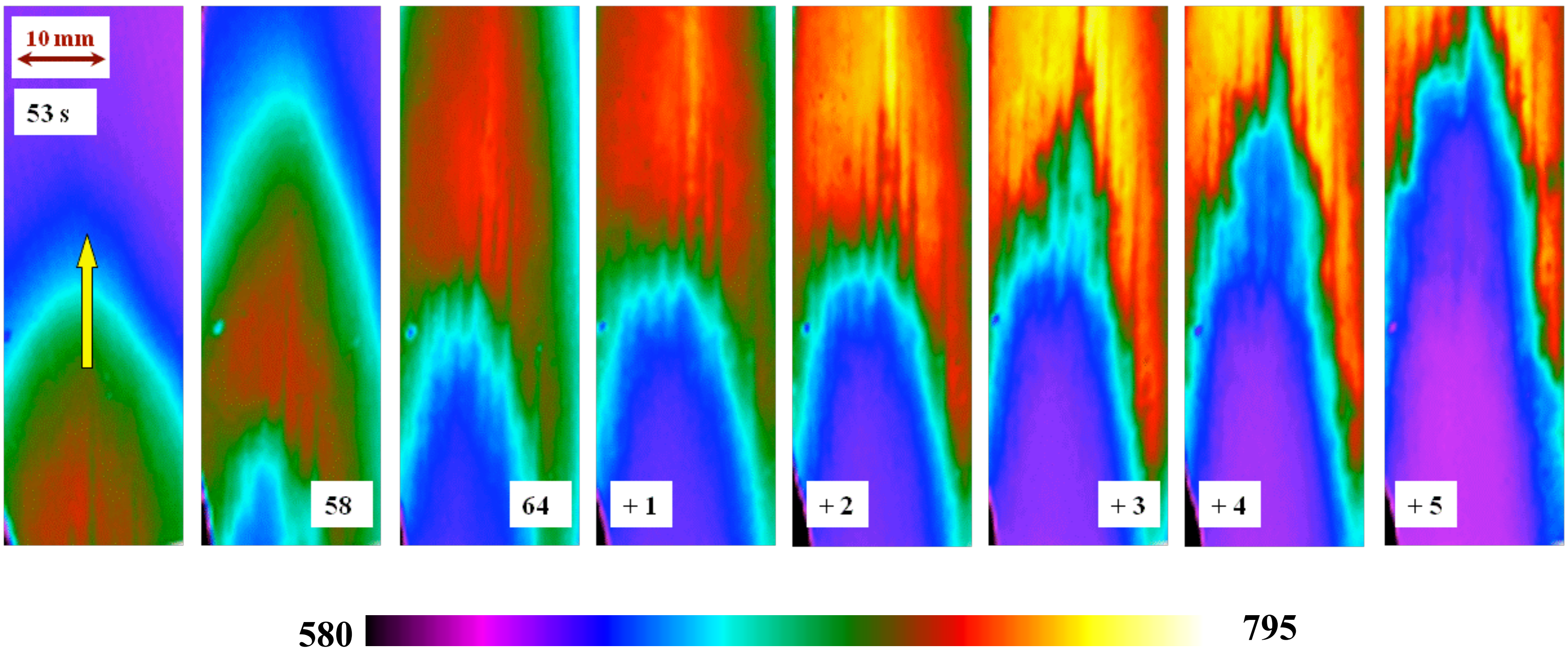
Wrong-way behavior of a packed bed reactor

Van Doesburg & DeJong Chem. Eng. Sci ,**31**,45 (1976)



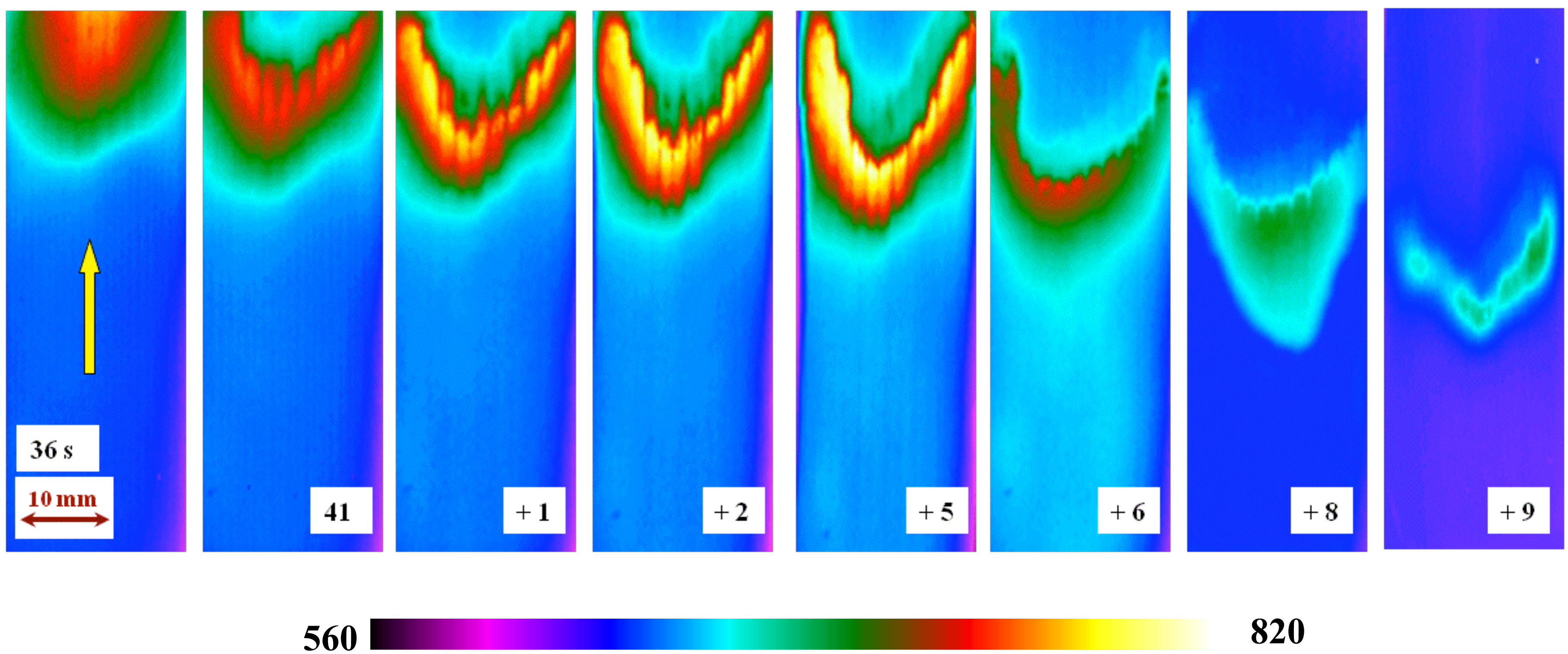
T drop from 620^{o}C to 520^{o}C, Max T= 770-740 = 30^{o}C

L=10 g/L, O_2= 10%, v= 5 cm/s



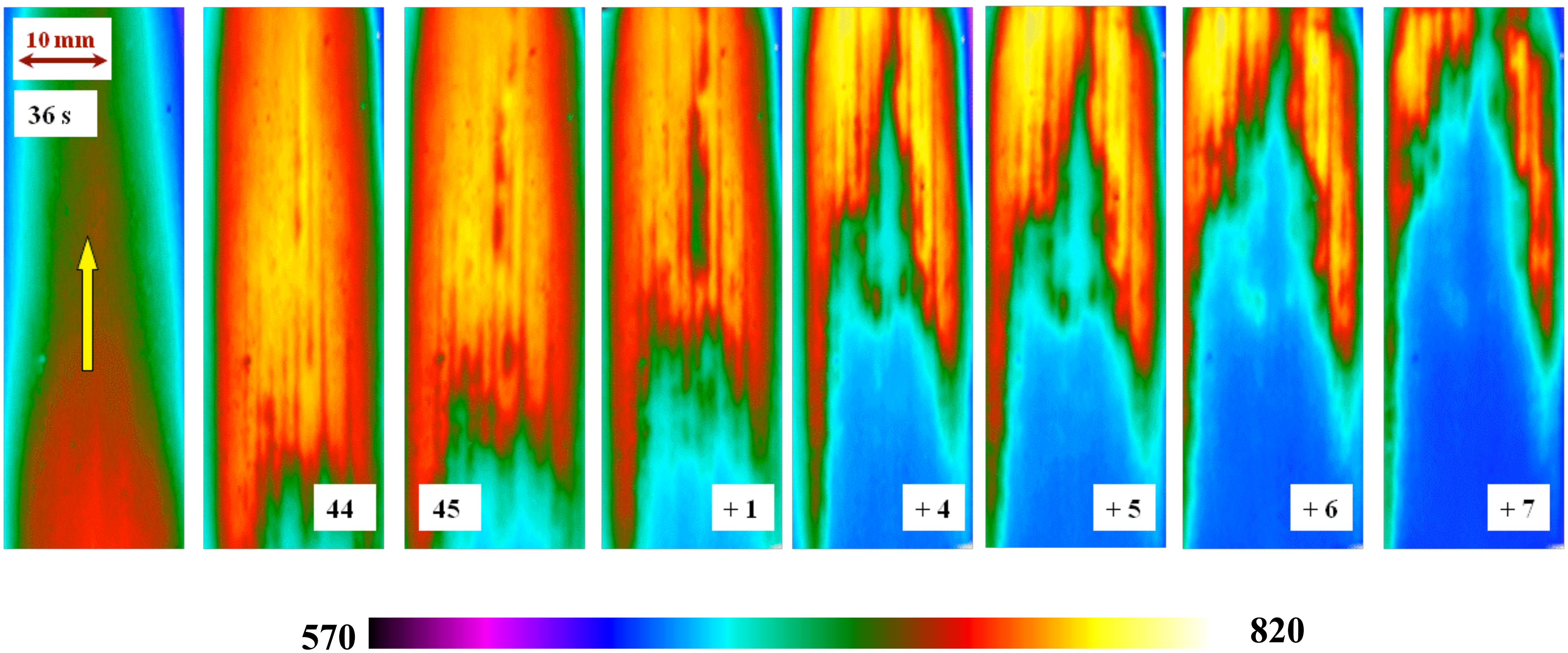
T drop from 620°C to 520°C, Max T= 813-762 = 51°C

L=10 g/L, O_2= 10%, v= 12 cm/s



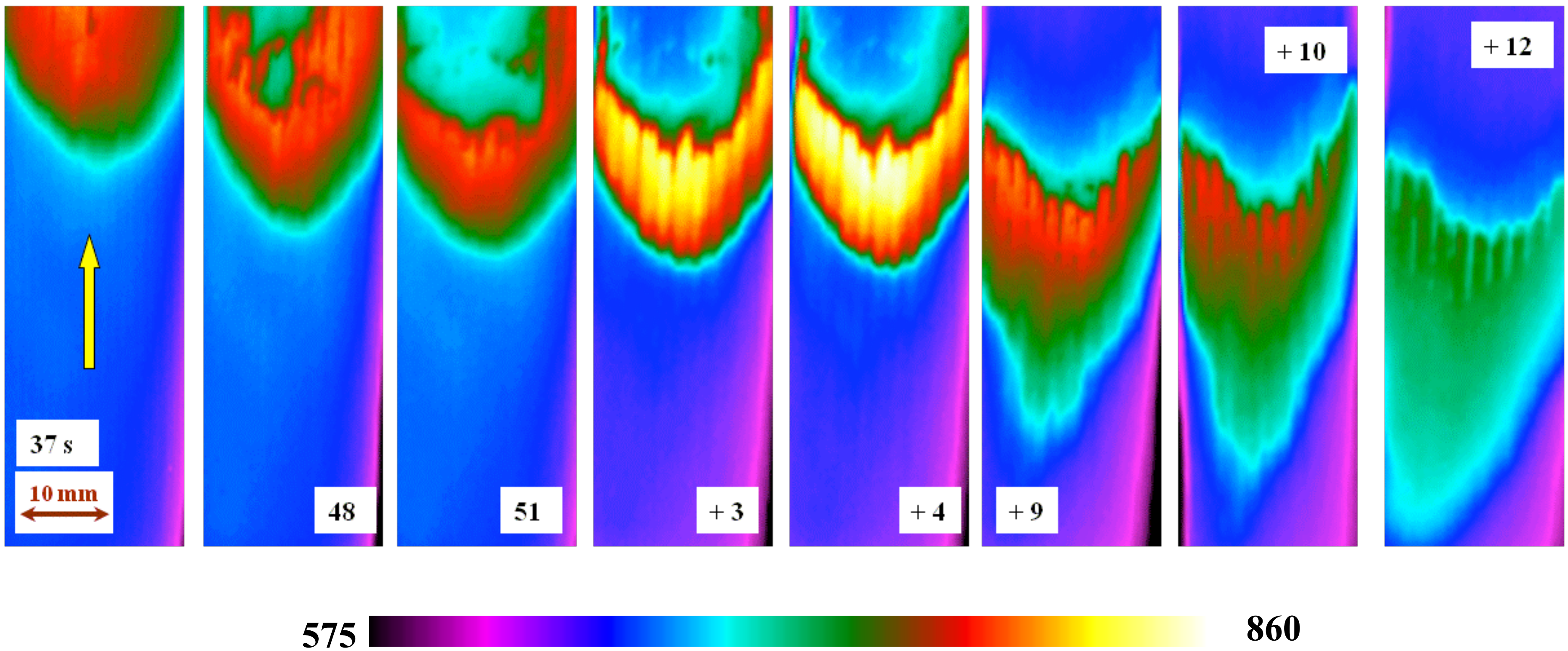
T drop from 620°C to 570°C,   Max T= 800-775= 25°C

L=20 g/L, O_2= 10%,   v= 12 cm/s



T drop from 620°C to 570°C, Max T= 807-775= 22°C

L=20 g/L, O_2= 12.5%, v= 12 cm/s



Concluding remarks

- Single layer experiments provide a qualitative but not a quantitative information about the maximum temperature rise and front dynamic features.
- Operating conditions affect mode of combustion on the maximum temperature rise in a DPF
- Sudden drop of temperature can lead to a wrong-way temperature rise

Thanks for your attention

Any questions, comments