POLYMER HEATS OF GASIFICATION

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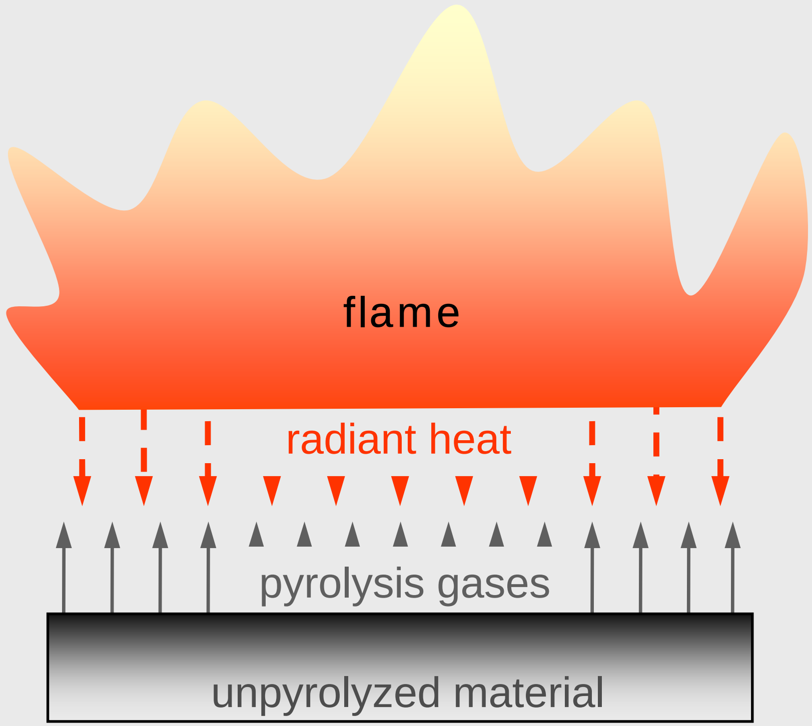
Combustion of Solids



burning intensity = pyrolysis mass flux × heat of combustion

$$\text{pyrolysis mass flux (steady-state)} = \frac{\text{heat flux into material}}{\text{heat of gasification}}$$

Thermodynamic Heat of Gasification (H_g)

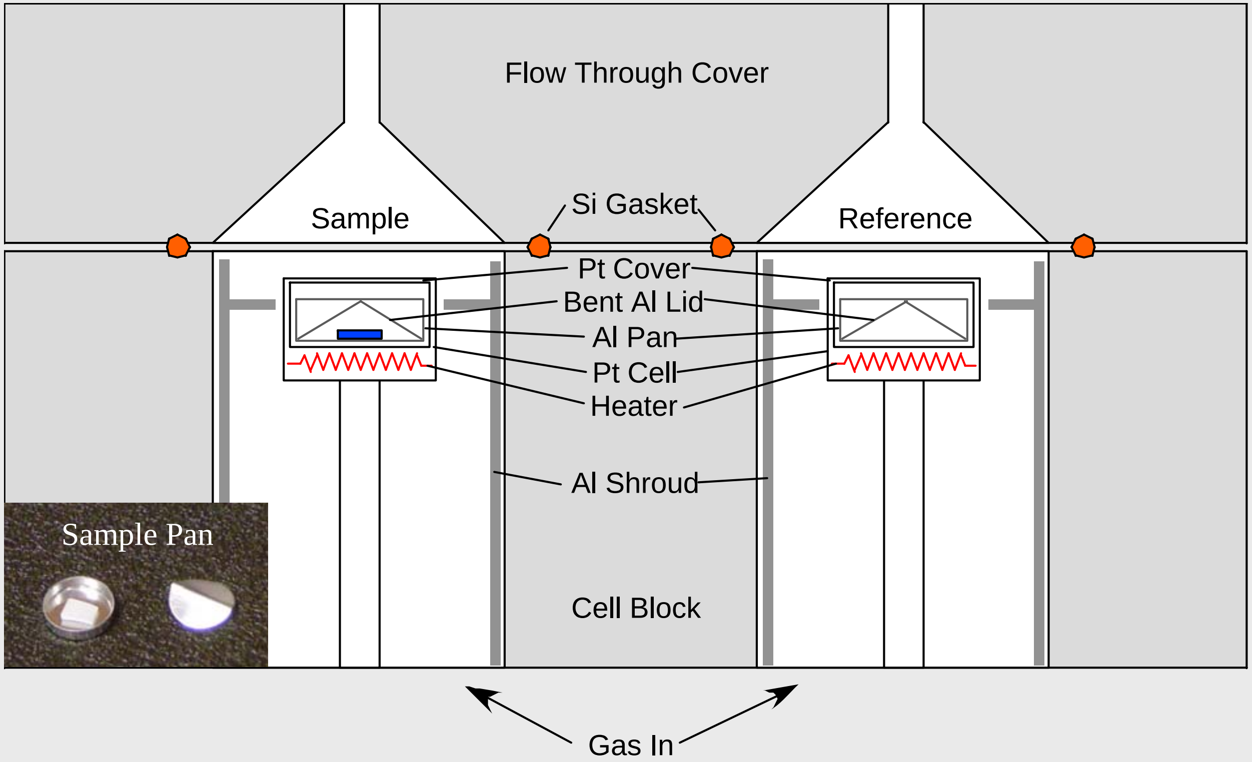
$$H_g = \int_{T_{init}}^{T_{dec}} C_{mat}\,dT + H_{melt} + H_{dec}(T_{dec}) + \int_{T_{dec}}^{T_{final}} C_{prod}\,dT$$

$$T_{dec} \approx T_{final} \quad \Rightarrow \quad C_{prod} \approx C_{mat}$$

$$\Downarrow$$

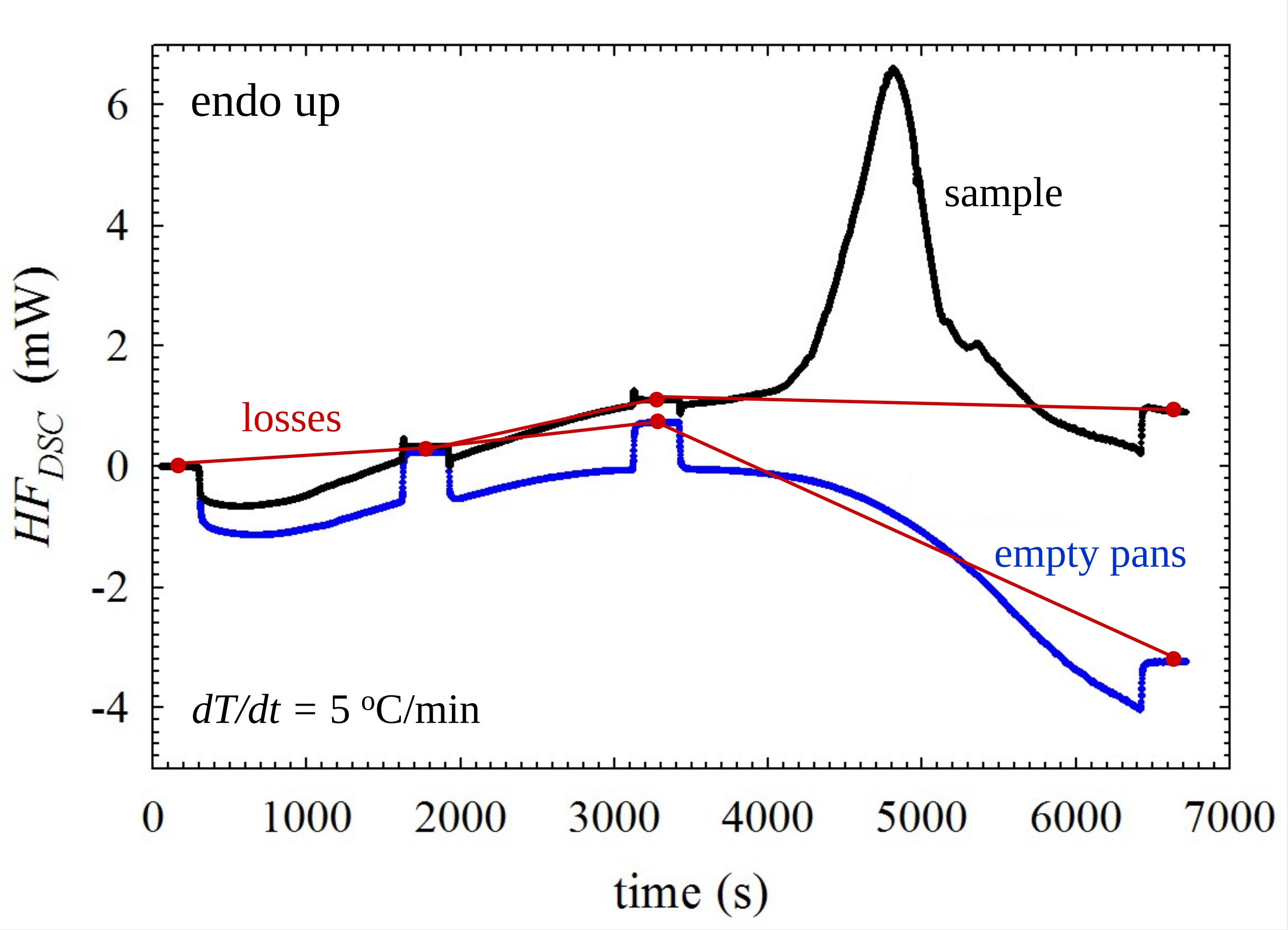
$$H_g = \int_{T_{init}}^{T_{final}} C_{mat}\,dT + H_{melt} + H_{dec}$$

Differential Scanning Calorimetry (DSC)

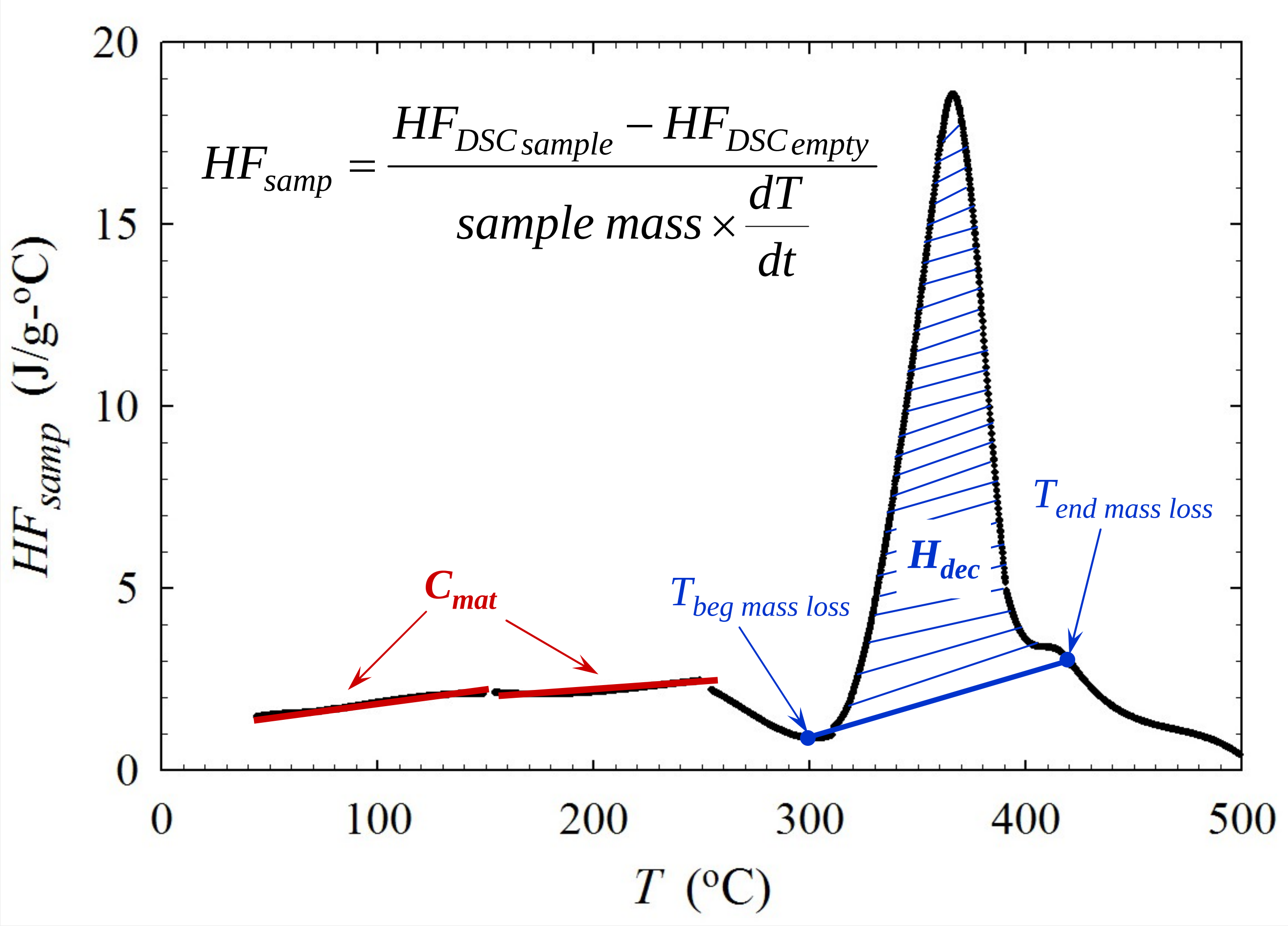


$$HF_{DSC} = HF_{samp} + (C_{samp.cell} - C_{ref.cell})\frac{dT}{dt} + HL_{samp.cell} - HL_{ref.cell}$$

DSC Heat Flow Analysis



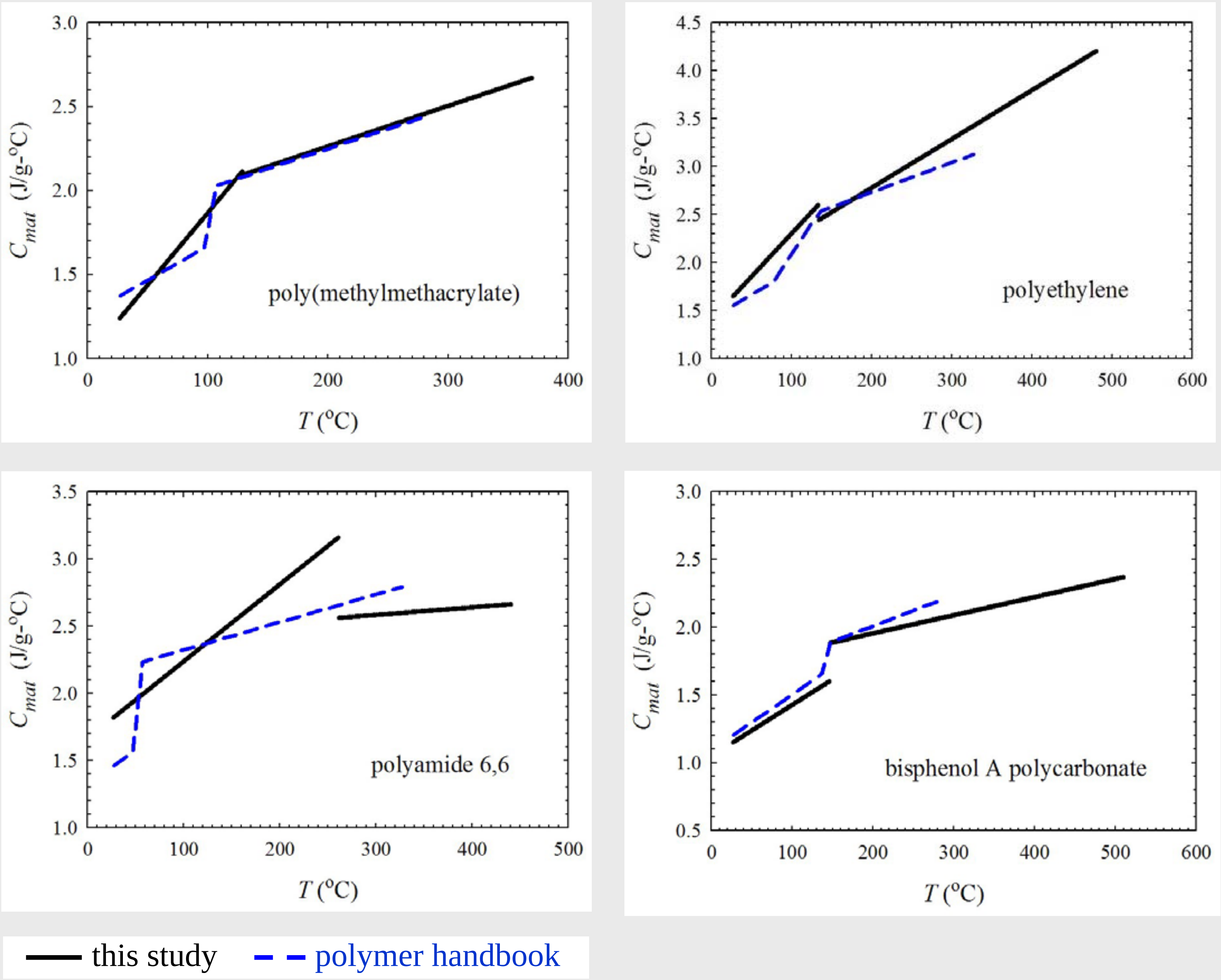
DSC Heat Flow Analysis



Materials

Polymer	Manufacturer	Trade Name	Distributor
poly(methylmethacrylate)	Atofina	Plexiglas G	Modern Plastics
poly(oxymethylene) (copolymer)	K-Mac Plastics	Kepital Acetal	Curbell
polyethylene (high density)	Poly Hi Solidur	HD Natural SR.	Modern Plastics
polypropylene	HPG International	Versadur 500	Modern Plastics
polystyrene (high impact)	Westlake Plastics	HIPS	Modern Plastics
polyamide 6,6	Quadrant EPP	Nylon 101	Modern Plastics
poly(ethylene terephthalate)	Ensinger	Ensitep	Modern Plastics
bisphenol A polycarbonate	GE Plastics	Lexan 9034	Modern Plastics
poly(vinylidene fluoride)	Elf Atochem	Kynar 740	Curbell
poly(vinyl chloride)	HPG International	Versadur 150	Modern Plastics

Heat Capacities



Melting

Polymer	T_{melt} °C	H_{melt} J/g	$H_{melt.crystal}$ J/g	**Crystallinity** %
poly(methylmethacrylate)	no melting peak observed			
poly(oxymethylene)	165	141 ±4	325	43
polyethylene	134	218 ±18	292	75
polypropylene	158	80 ±4	207	39
polystyrene	no melting peak observed			
polyamide 6,6	262	55 ±5	190	29
poly(ethylene terephthalate)	253	37 ±3	140	26
bisphenol A polycarbonate	no melting peak observed			
poly(vinylidene fluoride)	167	47 ±2	98	48
poly(vinyl chloride)	no melting peak observed			

Decomposition

Polymer	T_{dec} °C	H_{dec} J/g	$H_{dec.lit}$* J/g
poly(methylmethacrylate)	366	870 ±200	800
poly(oxymethylene)	369	2540 ±300	--
polyethylene	478	920 ±120	670
polypropylene	447	1310 ±70	630
polystyrene	427	1000 ±90	820
polyamide 6,6	438	1390 ±90	560
poly(ethylene terephthalate)	433	1800 ±80	--
bisphenol A polycarbonate	499	830 ±140	--
poly(vinylidene fluoride)	475	2120 ±250	--
poly(vinyl chloride)	276 475	170 ±170 540 ±390	-- --

* W. J. Frederick and C. C. Mentzer, Journal of Applied Polymer Science, 19, 1799 (1975).

Integral Heats of Gasification

Polymer	$\int_{25°C}^{T_{dec}} C_{mat}\,dT$ J/g	H_{melt} J/g	H_{dec} J/g	$H_g^{25°C\text{-}Tdec}$ J/g
poly(methylmethacrylate)	740 ±120	0	870 ±200	1610 ±230
poly(oxymethylene)	690 ±110	141 ±4	2540 ±300	3370 ±320
polyethylene	1370 ±220	218 ±18	920 ±120	2510 ±250
polypropylene	1150 ±180	80 ±4	1310 ±70	2540 ±190
polystyrene	800 ±130	0	1000 ±90	1800 ±160
polyamide 6,6	1050 ±170	55 ±5	1390 ±90	2500 ±190
poly(ethylene terephthalate)	730 ±120	37 ±3	1800 ±80	2570 ±140
bisphenol A polycarbonate	910 ±150	0	830 ±140	1740 ±210
poly(vinylidene fluoride)	910 ±150	47 ±2	2120 ±250	3080 ±290
poly(vinyl chloride)	710 ±110	0	710 ±430	1420 ±440

Conclusions

- The heat of gasification has been defined as a function of the initial and final temperatures of the gasification process.

- A methodology for determining parameters of this function has been developed and applied to a set of 10 non-charring and charring polymers.

- The future work will be focused on establishing quantitative relations between the heat of gasification and burning intensities measured in flammability tests.