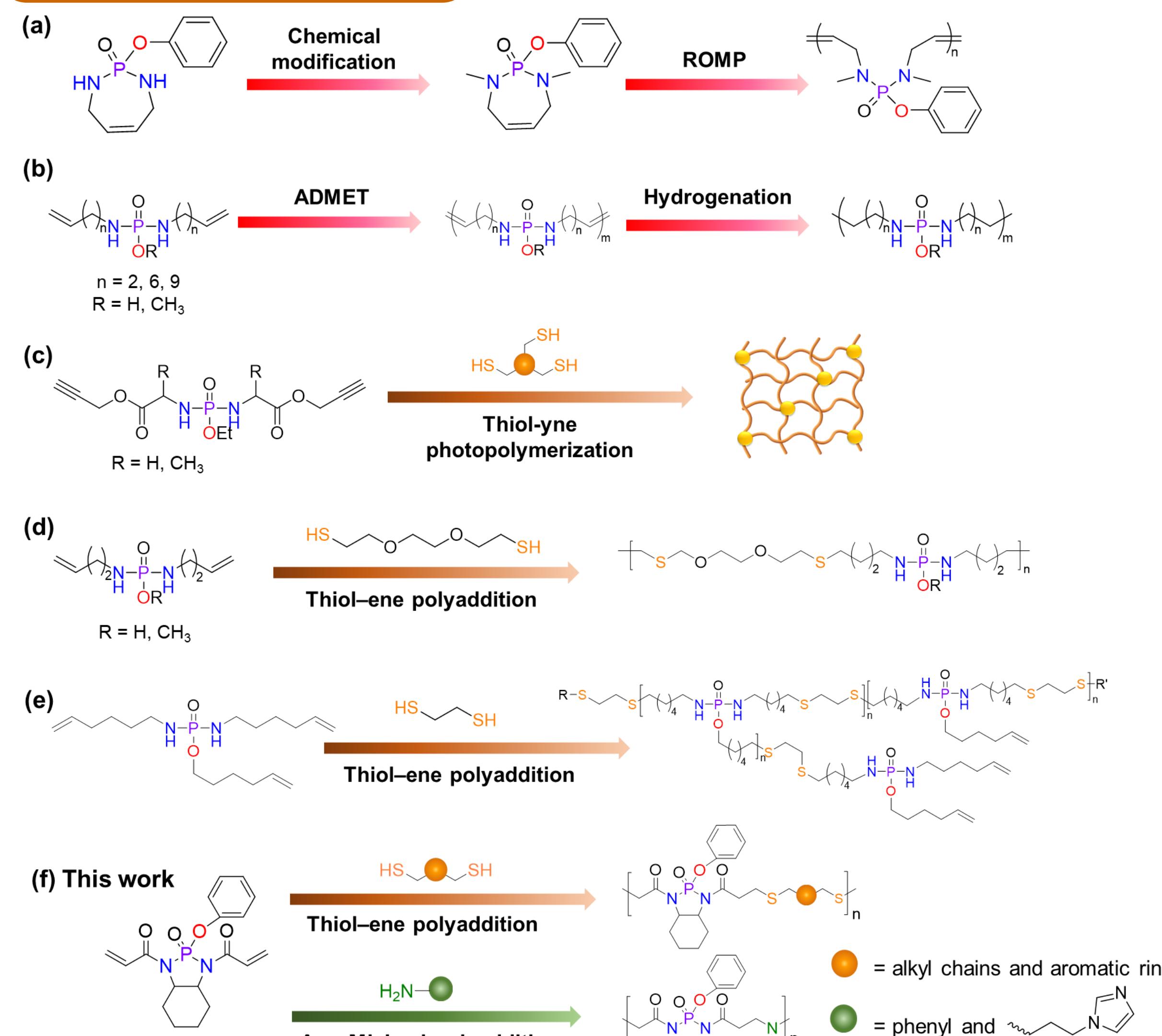


# New Class of Polyphosphorodiamides for Sustainable Applications

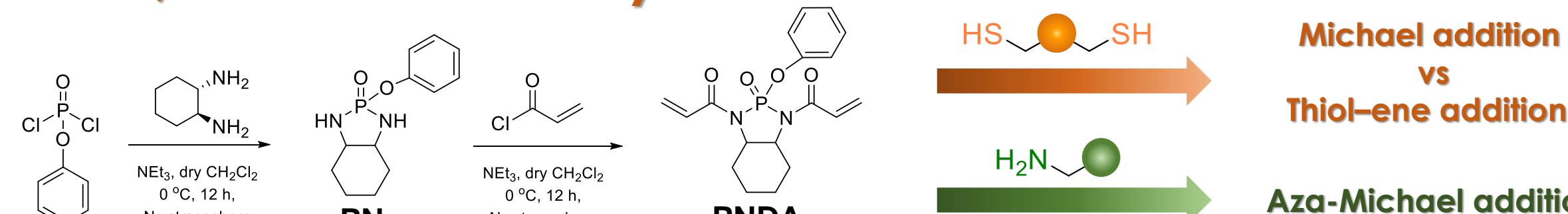
# 1 Challenge

Herein, we present the synthesis a phosphorus-containing content diacrylate monomer. The monomer was subsequently reacted with various amine and thiol compounds via thiol-ene and aza-Michael polyaddition to obtain a new class of polyphosphorodiamidates.

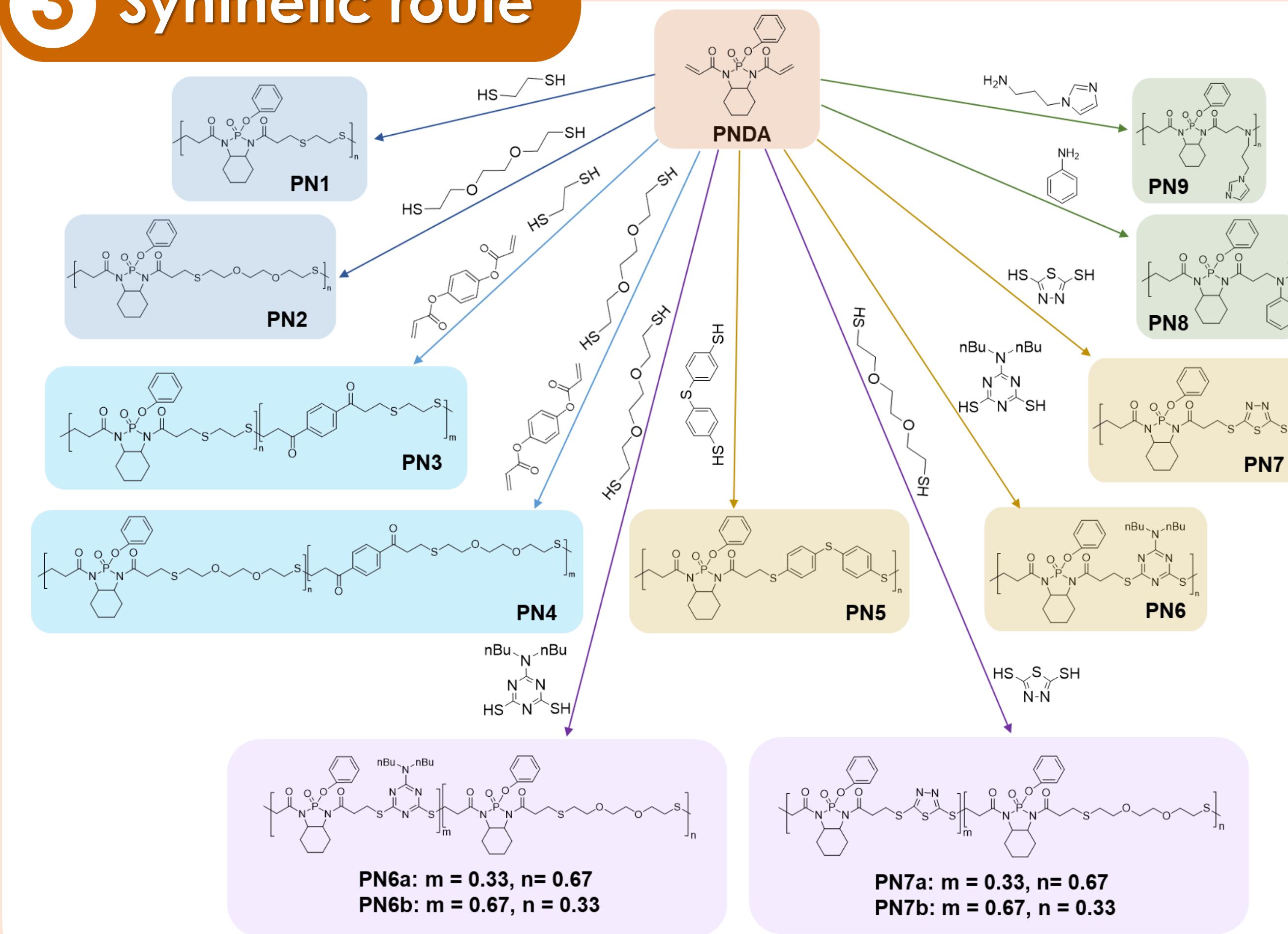
# 2 Concept



# PNDA, new monomer synthesis



# 3 Synthetic route

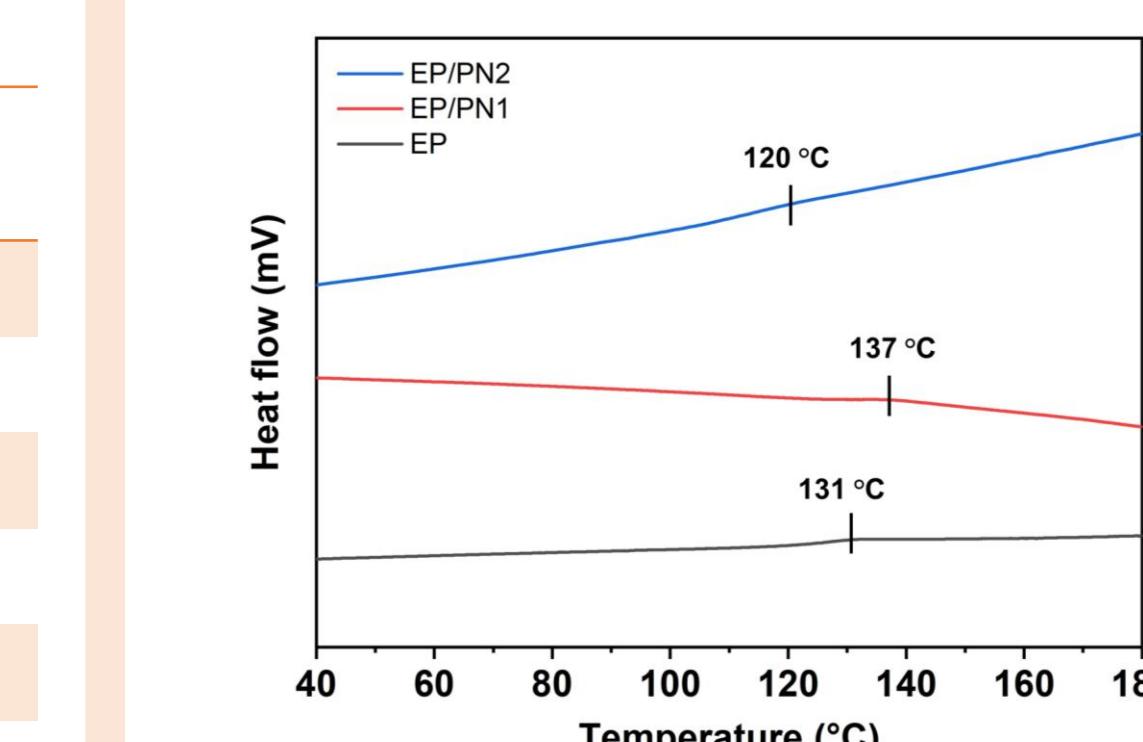
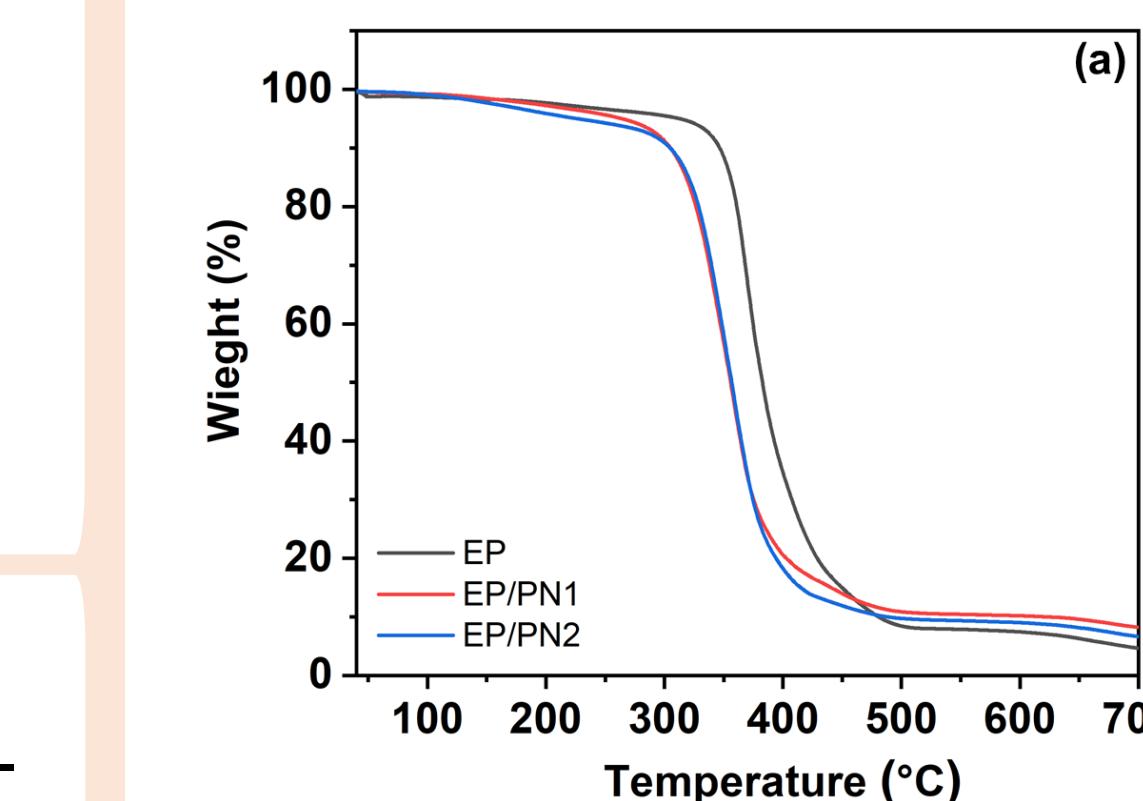
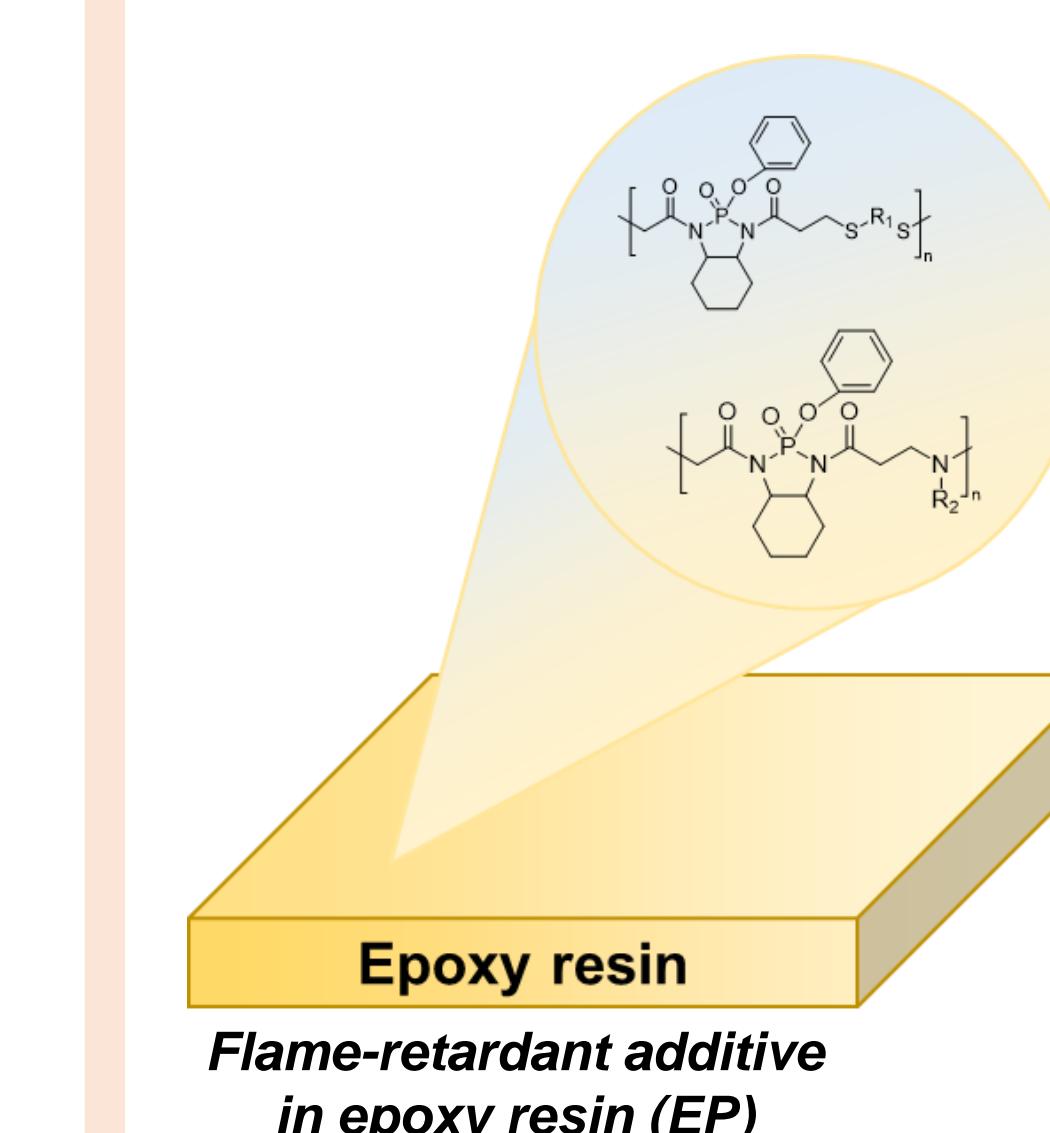


# Michael, Aza-Michael, and Thiol-ene Addition

Molecular weight ( $M_w$ ) and  $T_g$  prepared by Michael addition (PN1–PN7), a Michael addition (PN8–PN9), and radical thiol-ene polyaddition (PN1\*–PN

Michael	D (m <sup>2</sup> ·s <sup>-1</sup> )	M <sub>w</sub> (g·mol <sup>-1</sup> )	Radical	D (m <sup>2</sup> ·s <sup>-1</sup> )	M <sub>w</sub> (g·mol <sup>-1</sup> )	T <sub>g</sub> (°C)
PN1	$3.32 \times 10^{-11}$	35,750	PN1*	$1.03 \times 10^{-10}$	8,750	-
PN2	$5.70 \times 10^{-11}$	8,750	PN2*	$1.25 \times 10^{-10}$	5,250	-1
PN3	$6.62 \times 10^{-11}$	5,950	PN3*	$9.20 \times 10^{-11}$	11,600	10
PN4	$6.64 \times 10^{-11}$	5,900	PN4*	$1.11 \times 10^{-10}$	7,100	10
PN5	$9.57 \times 10^{-11}$	2,300	PN5*	cross-linked		
PN6	$7.06 \times 10^{-11}$	5,000	PN6*	$3.11 \times 10^{-10}$	500	60
			PN6a*	$1.39 \times 10^{-10}$	3,950	-
			PN6b*	$2.19 \times 10^{-10}$	1,200	-
PN7	$7.57 \times 10^{-11}$	4,200	PN7*	$3.37 \times 10^{-10}$	400	90
			PN7a*	$8.51 \times 10^{-11}$	14,300	-
			PN7b*	$9.77 \times 10^{-11}$	9,950	-
PN8	$1.26 \times 10^{-10}$	5,100				30
PN9	$8.73 \times 10^{-11}$	13,400				70

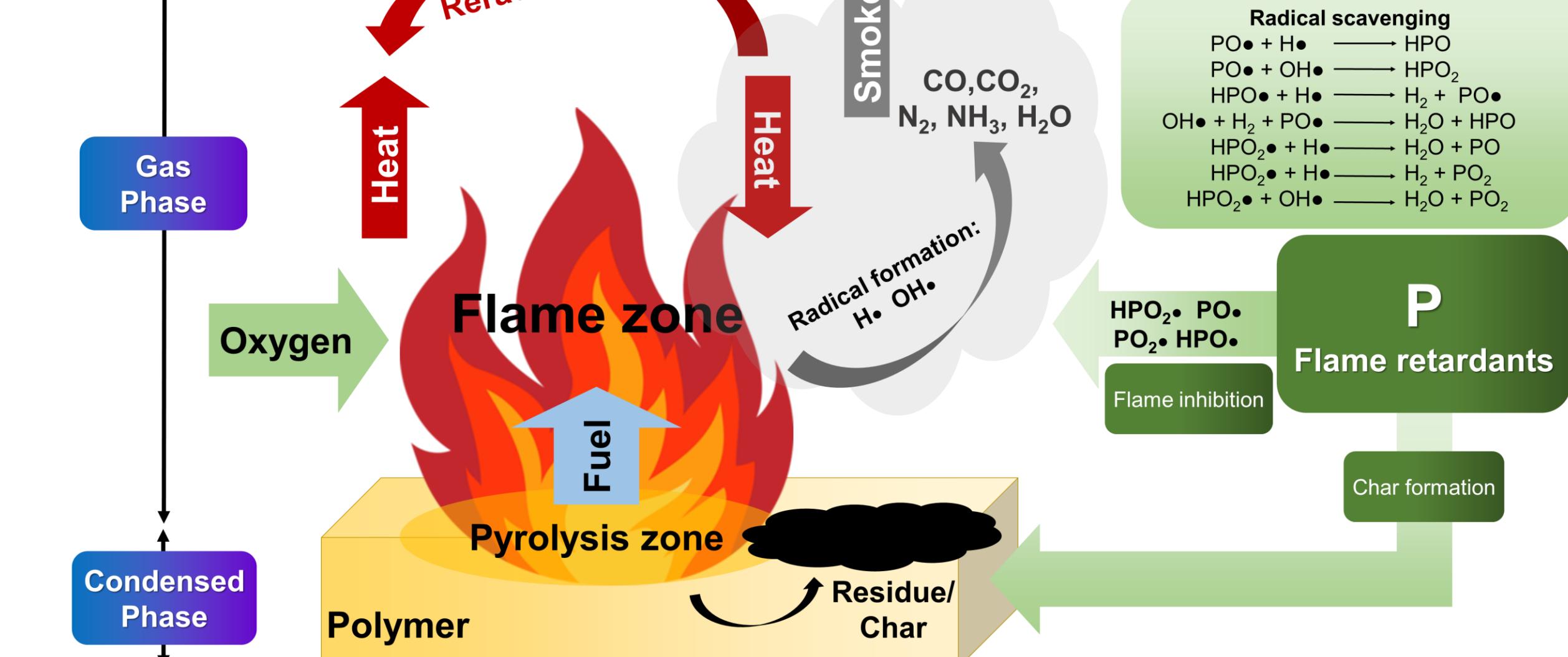
# Thermal and Flammability Test



## Higher P content

## Higher thermal stability

Increase  $T_g$   Better Flame-retardant



# 4 Conclusions

## Phosphorus-containing polymers with improved thermal stability and flame-retardant were synthesized