



Synthesis of Energetic Thermoplastic Elastomers by Using Controlled Radical Polymerization

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Outlines of presentation

- Introduction
 - Insensitive munitions (IM)
 - GAP binder
 - Controlled/living free radical polymerization
- Objective
- Results and Discussion
- Conclusions
- Acknowledgments

Insensitive munitions (IM)

- High vulnerability of ammunitions and development of insensitive munitions (IM).
- Requirements for Insensitive munitions criteria
 - high performance, low sensitivity, environmental acceptance, and reasonable costs.
- Applied of polymeric materials (inert/energetic) in low sensitivity munitions (binders/plasticizers).

GAP binders

- Glycidyl azide Polymer (GAP)
- Formation of binder system based on urethane reaction (Condensation polymerization).
- Limitations with urethane binders.

-Vandenberg, E. J., U.S. Patent, 1972.

-Bharti Gaur, Bimlesh Lochab, V. Choudhary, I. K. Varma, *Journal of Macromolecular Science Part C-Polymer Reviews*, C43, 505-545 (2003)

Controlled Free radical polymerization

- Characteristics of Controlled radical polymerization.
- Requirements for controlled free radical polymerization.
- Controlled radical polymerization methods
 - Dithiocarbamate iniferters
 - A nitroxide-mediated process (NMP)
 - Atom transfer radical polymerization (ATRP)
 - Reversible addition-fragmentation transfer (RAFT)

OBJECTIVE

- Utilization of controlled free radical polymerization method in synthesis of energetic thermoplastic elastomers binder

Scope

- Synthesis of GAP as Macro-initiators (1)
- Controlled free radical polymerization (2)
- Characterization of final energetic binder (3)

RESULTS AND DISCUSSION

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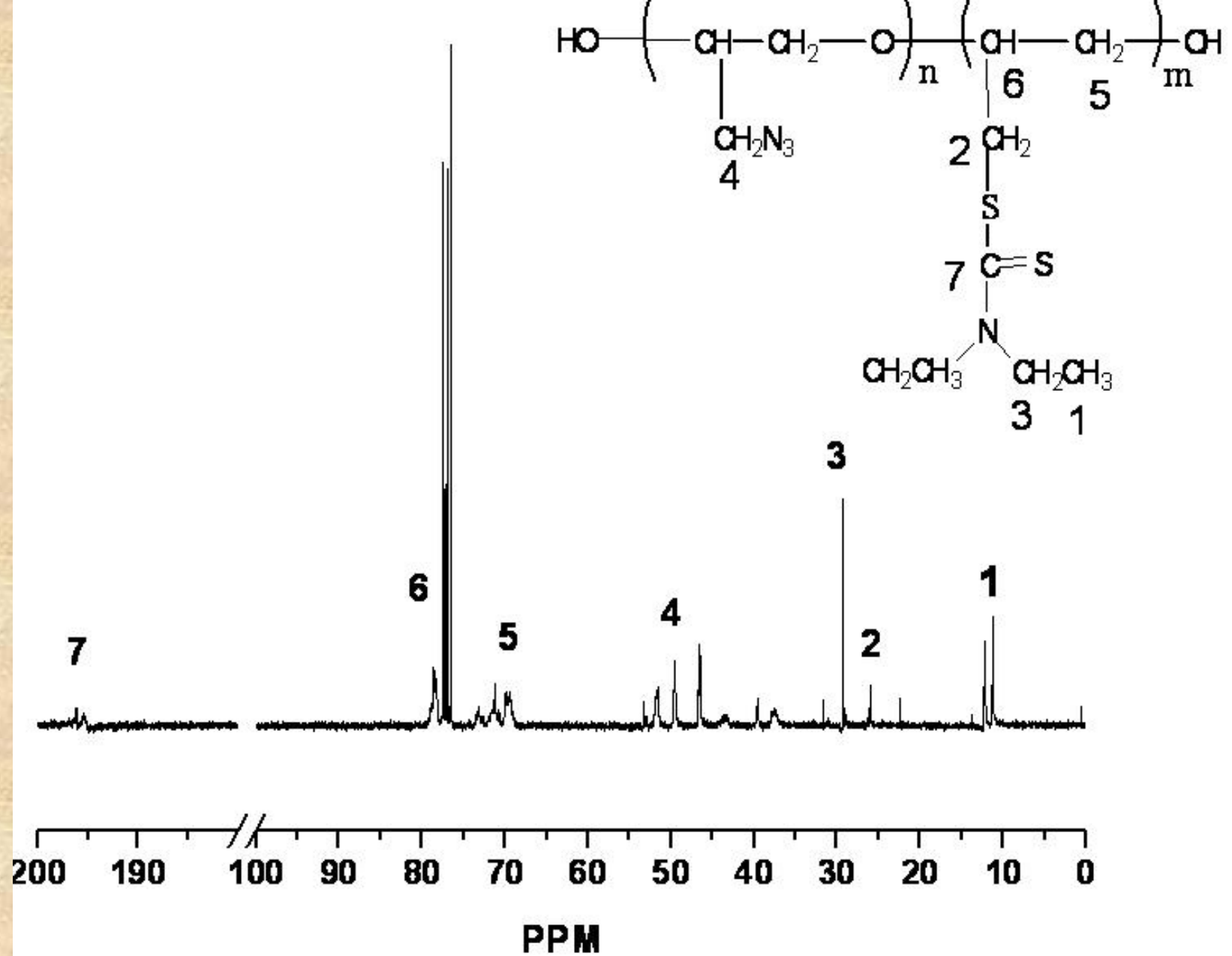


Figure.1. ^{13}C NMR(CDCl_3) spectrum of GAP Macro-initiators.

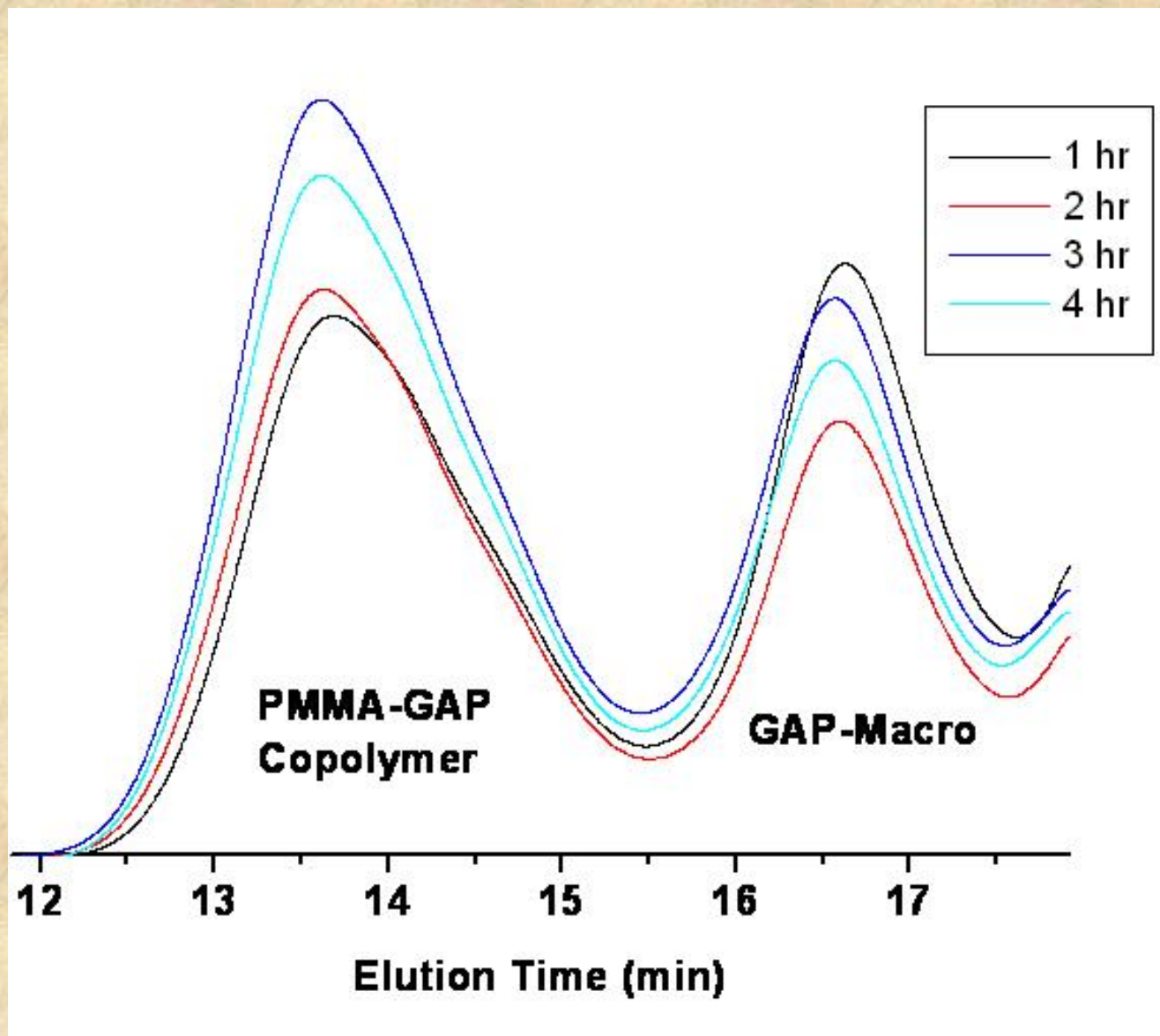


Figure.2. GPC profiles of photopolymerization of methyl methacrylate in toluene initiated by GAP-Macroinitiator.

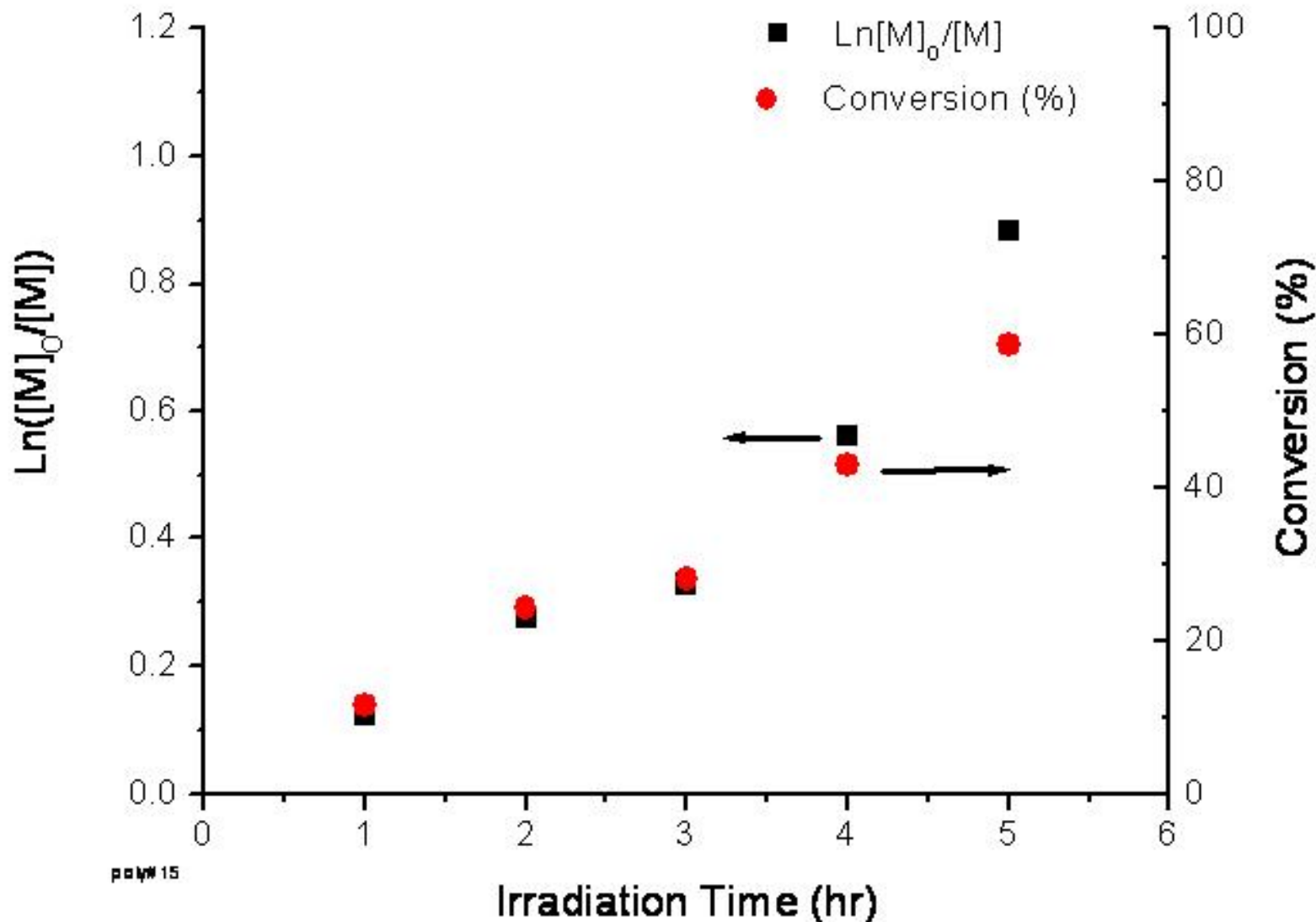


Figure.3. First-order time- conversion plots for the photopolymerization of MMA in toluene initiated by GAP-g-DDC ($[GAP-g-DDC]/ [MMA] = 0.014$).

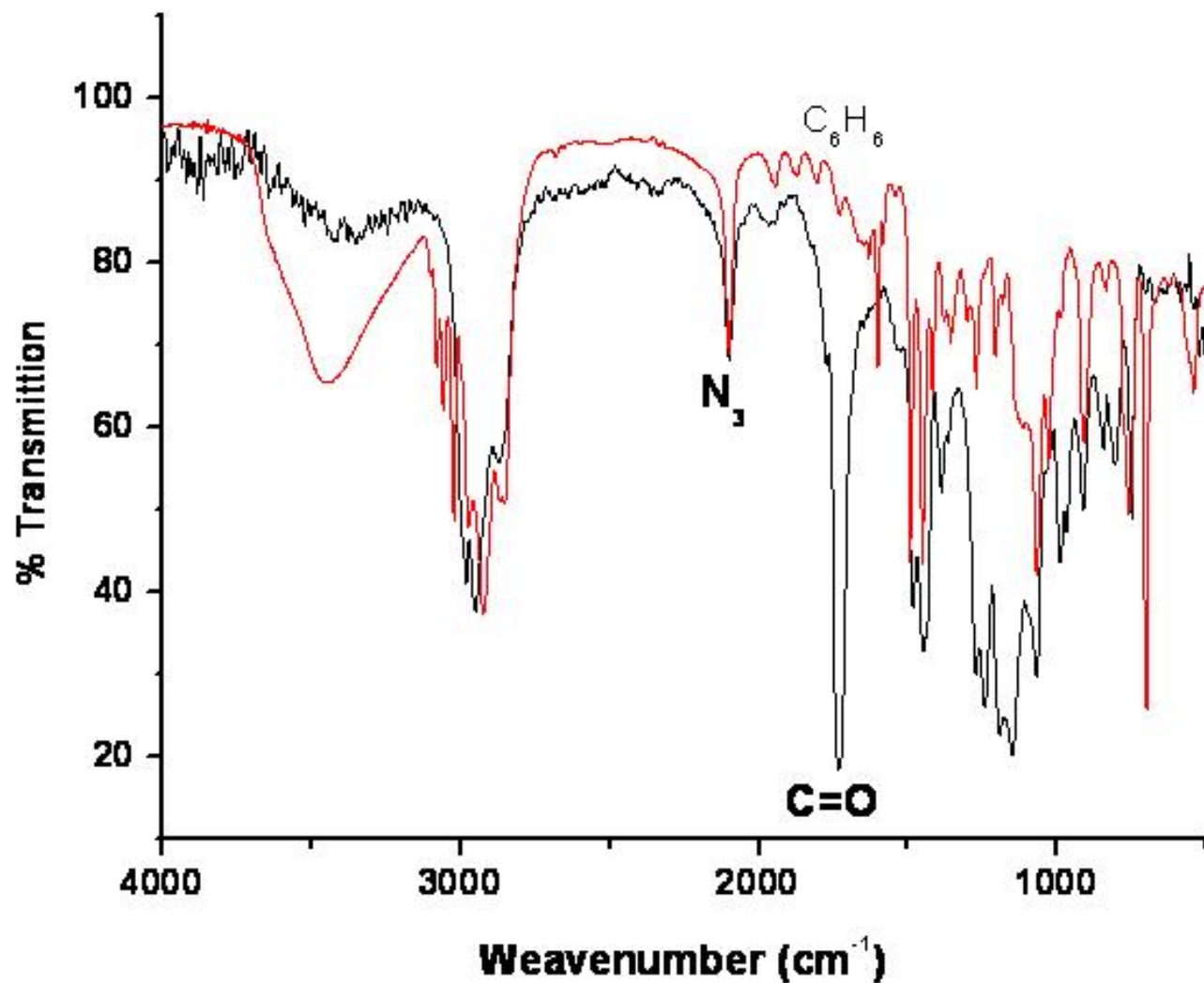


Figure.4. FT-IR spectrum of PMMA-g-GAP (black line) and PSt-g-GAP (red line) copolymer.

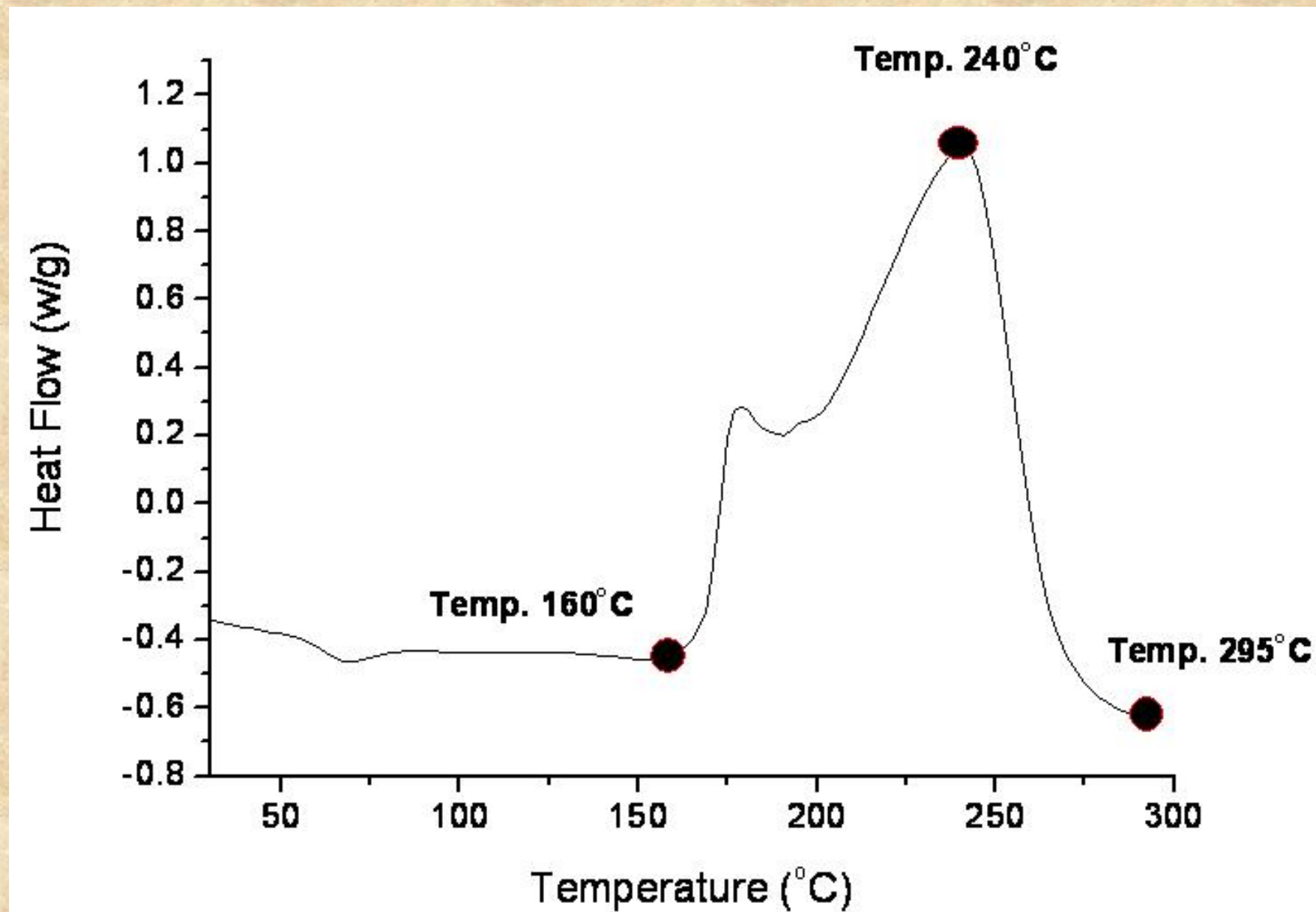


Figure.5. DSC traces of PMMA-g-GAP copolymer (1.159 mg).

CONCLUSIONS

- Energetic thermoplastic elastomers prepared by controlled free radical Polymerization.
- GAP-macro-initiator proofed with different techniques.
- Polymerization proceed in controlled fashion.
- Binder decomposition at about 250°C and compatible with explosives (RDX).

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