Molecular Mass and Composition Dependence of Glass Transition Temperature in PC/PMMA Blends

Thomas Murray (Fayetteville State University)
Guangcui Yuan (NCNR)

PREM
PARTNERSHIPS FOR RESEARCH AND EDUCATION IN MATERIALS

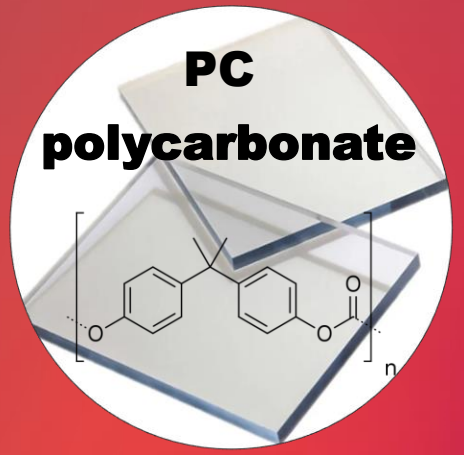
FAYETTEVILLE STATE BRONCOS

NIST CENTER FOR NEUTRON RESEARCH

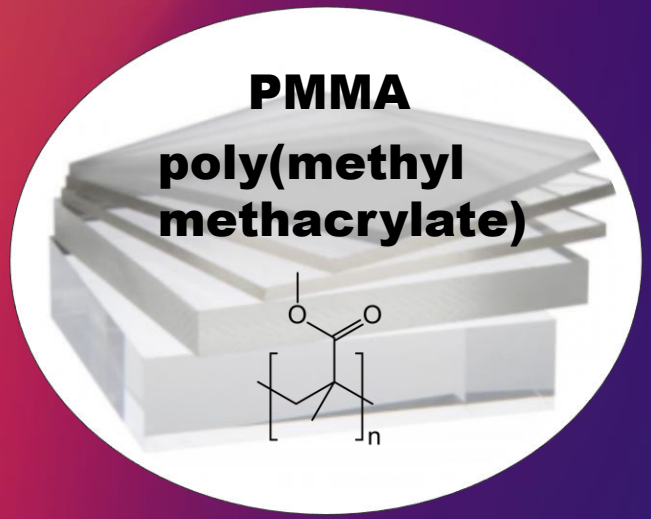
NSF CHRNS CENTER FOR HIGH RESOLUTION NEUTRON SCATTERING NIST

CONTENTS

INTRODUCTION



Vs

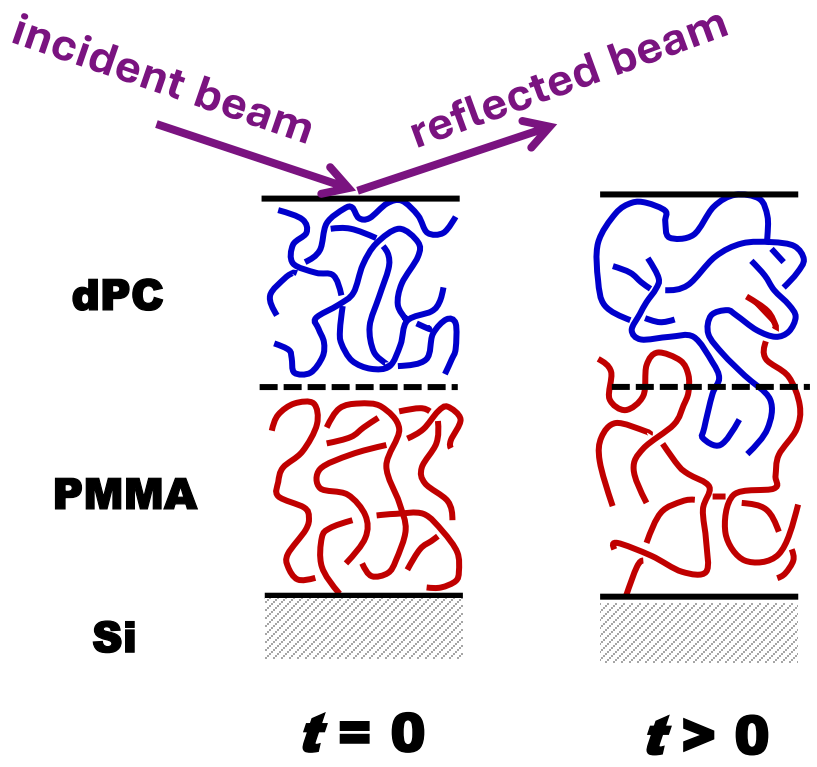


property	PC	PMMA
Tensile strength	27-75	65-83
Transparency	> 88%	> 92%
Chemical resistance	Strong resistance to many common chemicals including acids, salt, oil and alcohols.	Poor resistance to salts. Degrade in contact with acid, alkalines and alcohols.
Heat Deflection T	127-147°C	≤ 110-115 °C
mechanical	Do not crack during drilling	Not being scratched easily

- **Background:** Blending of polymers is a simple, versatile, and economical tool for developing new polymer materials with tailored properties.
- **Significance:** Blending of PC with PMMA is believed to have the potential to allow some technical shortcomings of PC to be overcome, such as scratch sensitivity or birefringence, while retaining the appreciated unique benefits of PC, such as chemical resistance, good heat deflection, and impact resistance.
- **Objective:** This study focuses on the molecular mass and mixing ratio effects on the miscibility of PC/PMMA blends

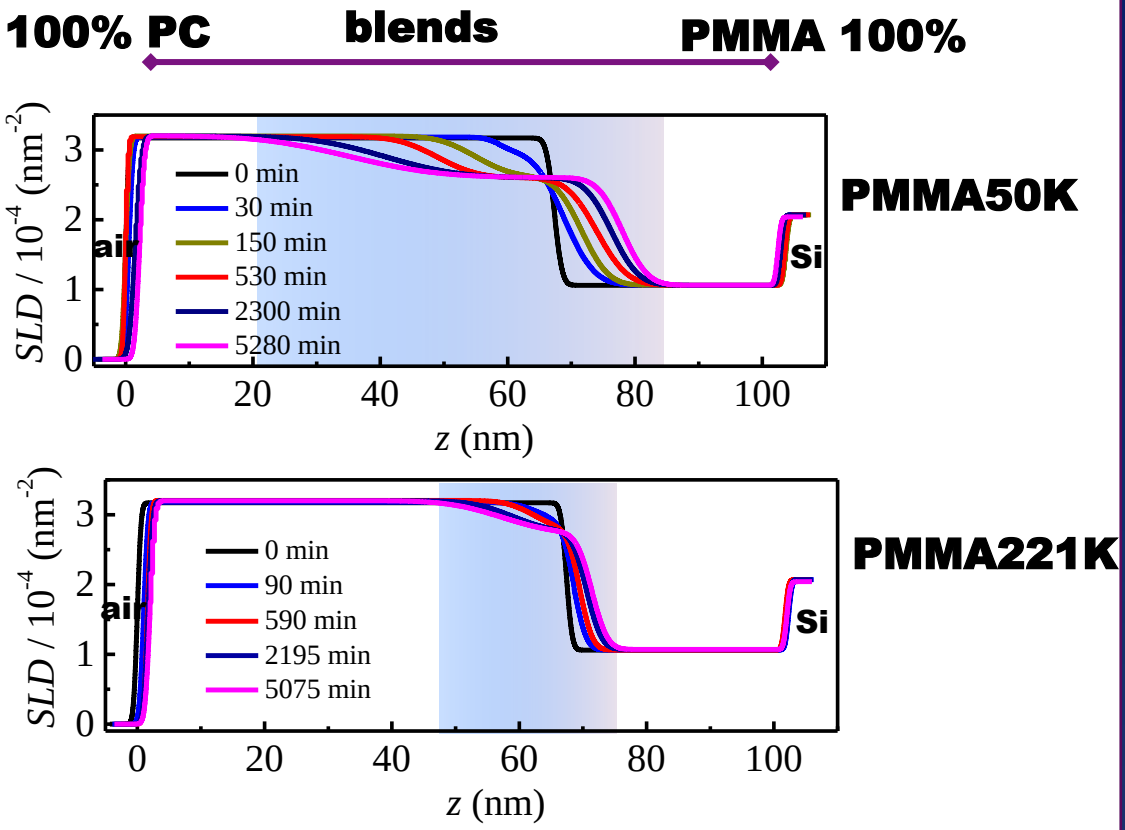
INTRODUCTION

neutron reflection and interfacial diffusion



145 °C

asymmetrical interdiffusion and slowdown



- **Objective:** This work also aims to provide insight into another study—the interfacial diffusion between PC-PMMA by neutron reflection.

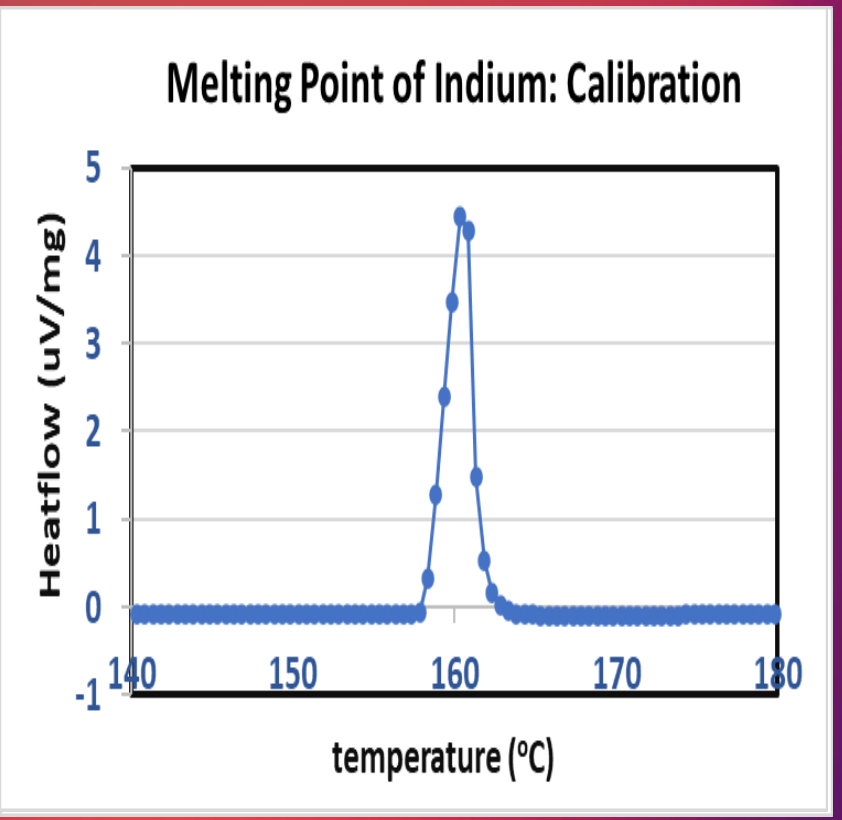
MATERIALS

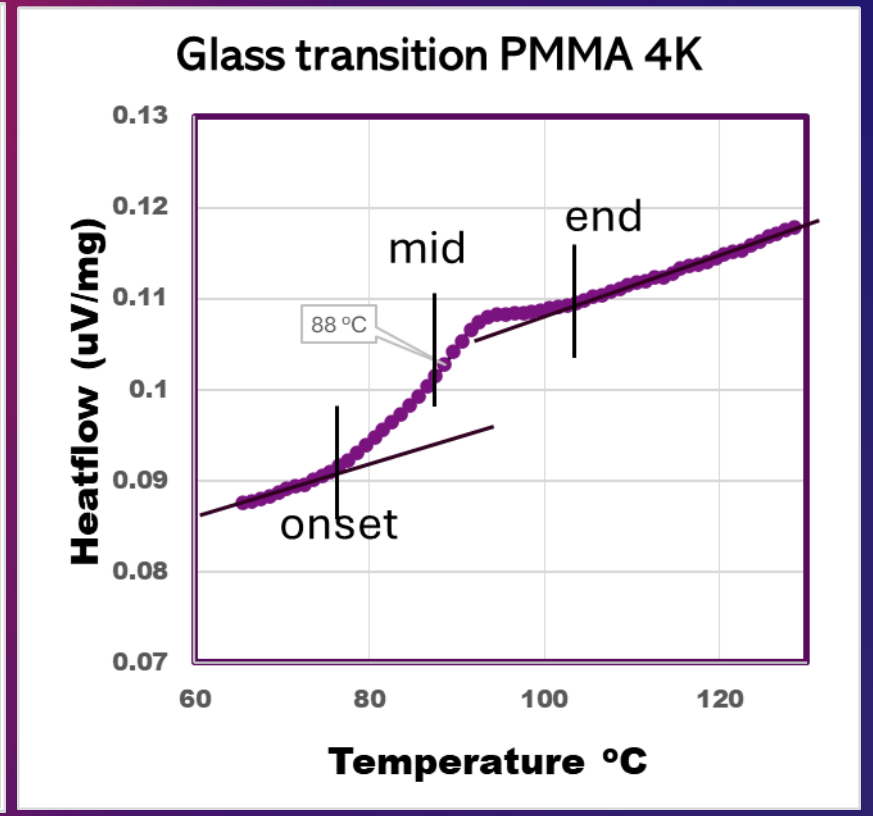
Polymer	Mn (g/mol)	n (repeat unit)	PDI (polydispersity)	Rg (radius of gyration)	Tg (°C)
PMMA 4K	3,800	40	1.13	1.6 nm	88
PMMA 50K	50,000	500	1.11	5.7 nm	121
PMMA 221K	221,800	2218	1.16	12.6 nm	127
PMMA 1083K	1,083,000	10830	1.16	26.5 nm	128
dPC	84,000	368	2.41	11 nm	151

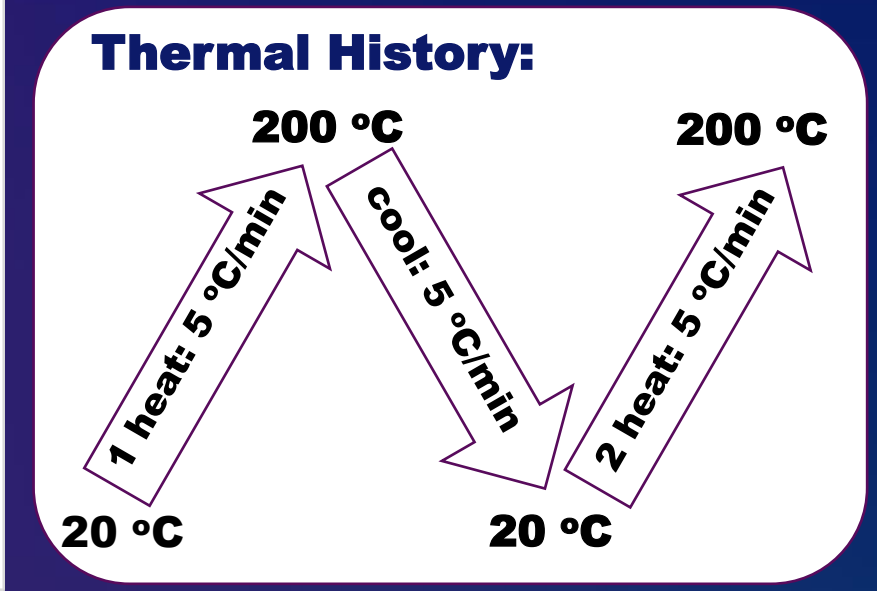
PREPARATION

PMMA/PC mixture (85/15; 70/30; 50/50; 30/70; 15/85) → **solvent CH_2Cl_2** → **solution casting 60 °C** → **vacuum dry > 24 hr**

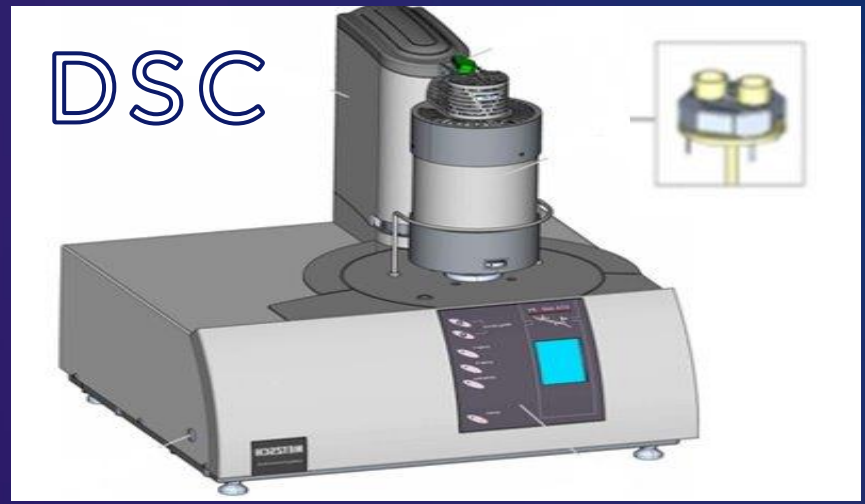
METHOD





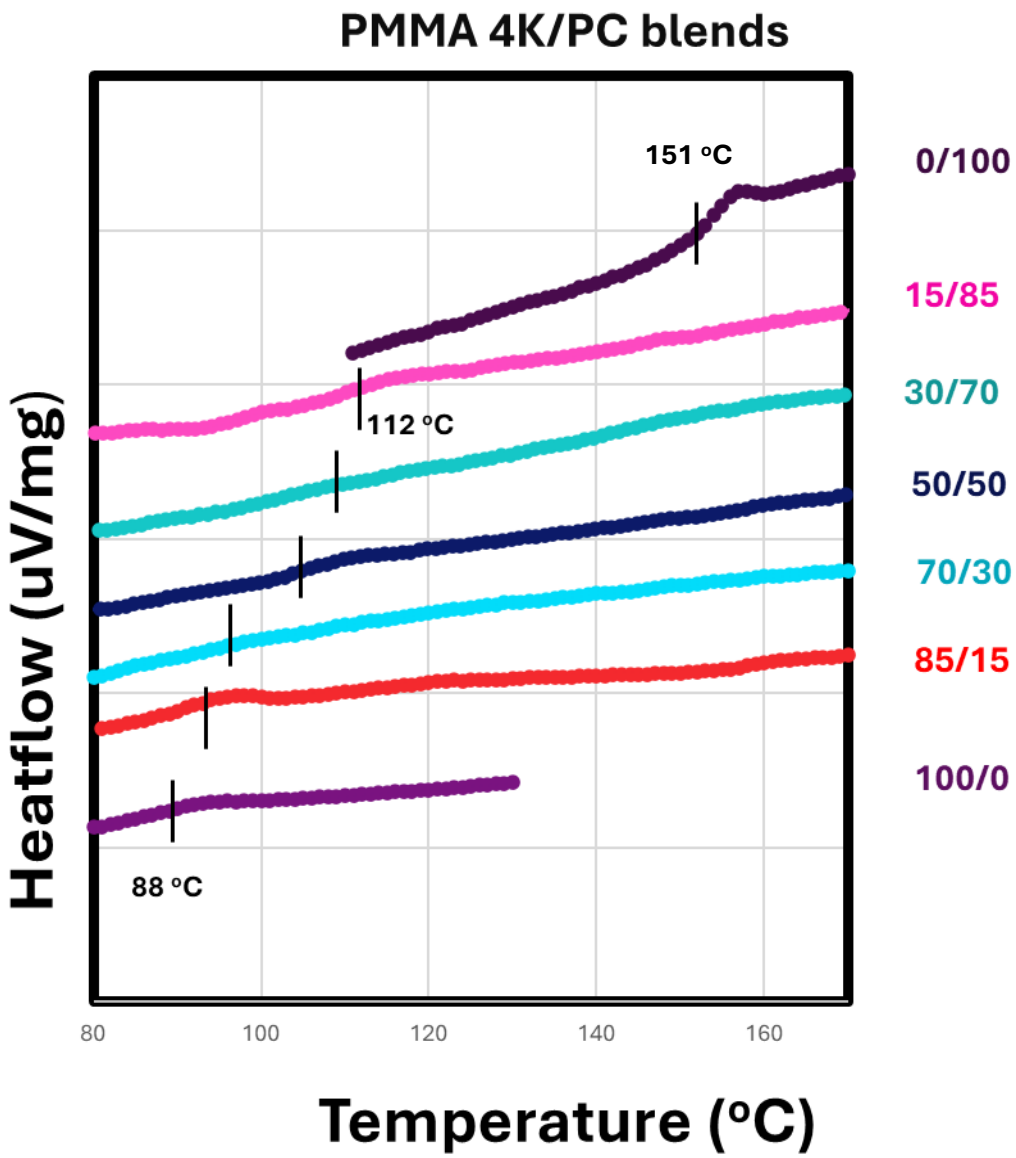


- **Differential scanning calorimetry (DSC)---** **determines the temperature and heat flow associated with material transitions as a function of time and temperature. It also provides quantitative and qualitative data on endothermic (heat absorption) and exothermic (heat evolution) processes of materials during physical transitions that are caused by phase changes.**



RESULTS PMMA4K/PC

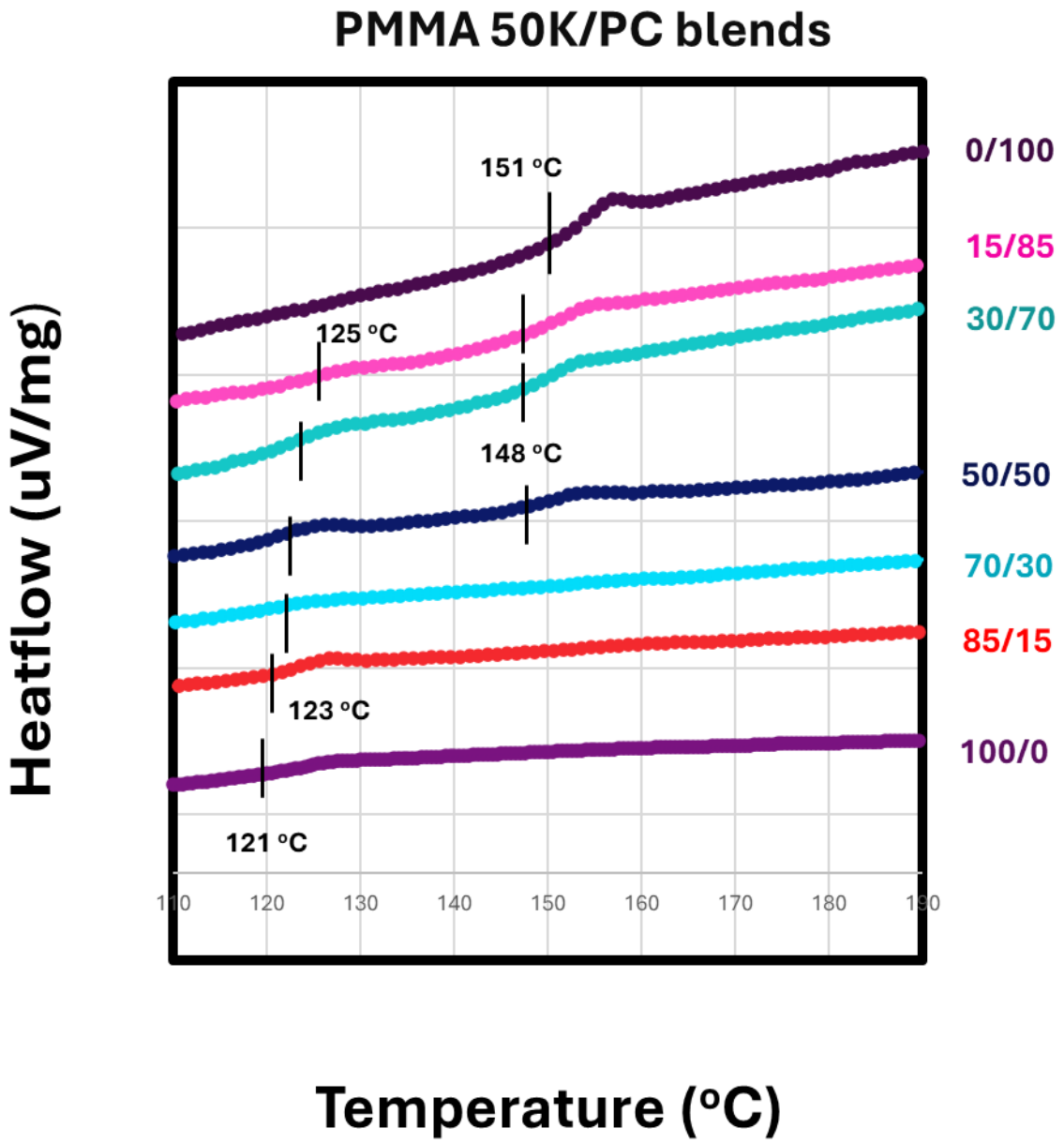
- There is a single glass transition temperature in all blends.
- The Tgs are shifted from the values of 100% PMMA to higher with increasing PC content.
- From the above, we conclude that the PMMA4K/PC blends are miscible over the whole composition range.



RESULTS PMMA50K/ PC

- There is a single glass transition temperature in blends with PMMA50K content >50%, indicates these blends are completely miscible.

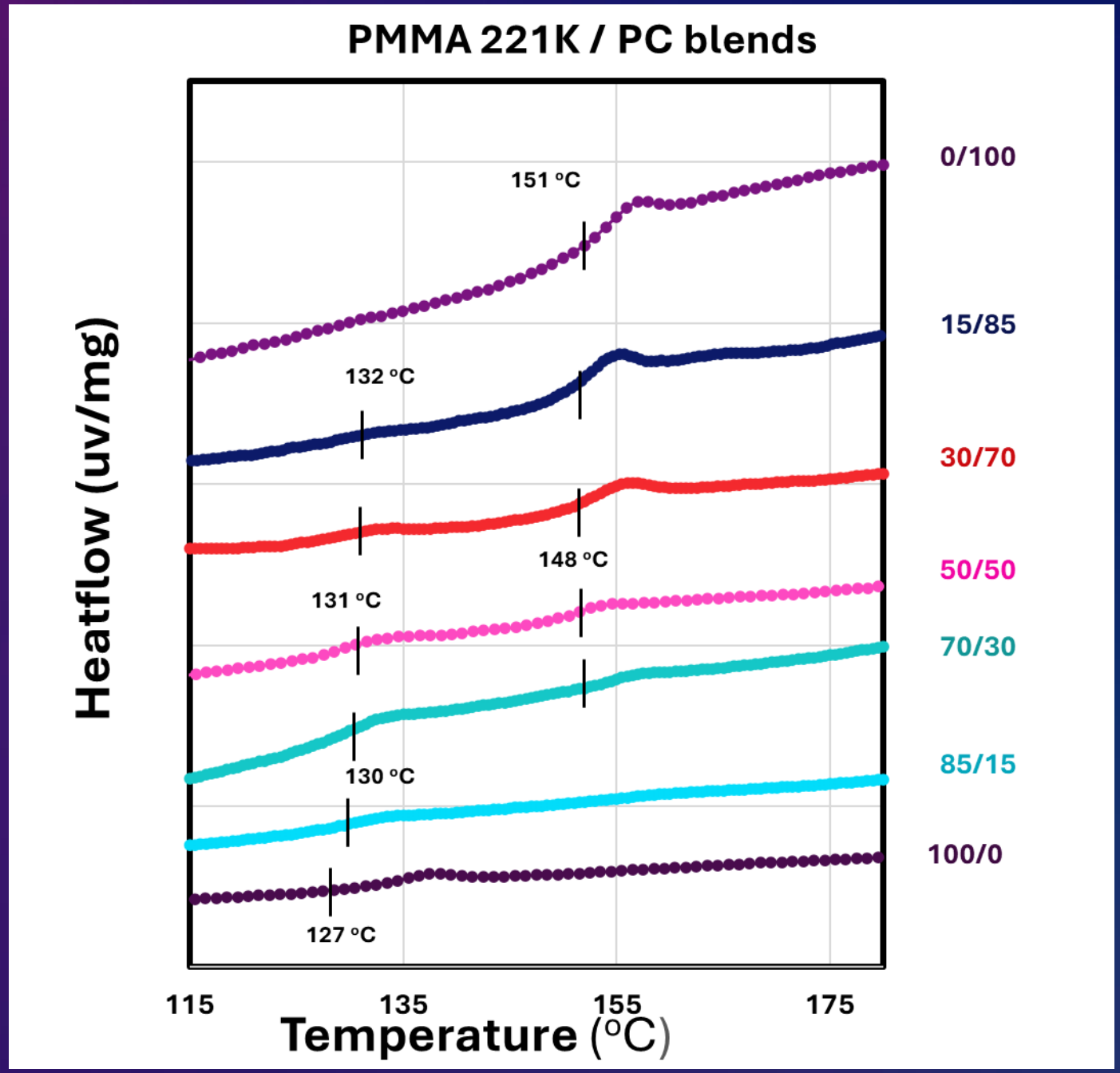
- Two distinct glass transitions appear in blends with PMMA50K content ≤ 50%, indicating partly miscibility.



RESULTS PMMA221K/ PC

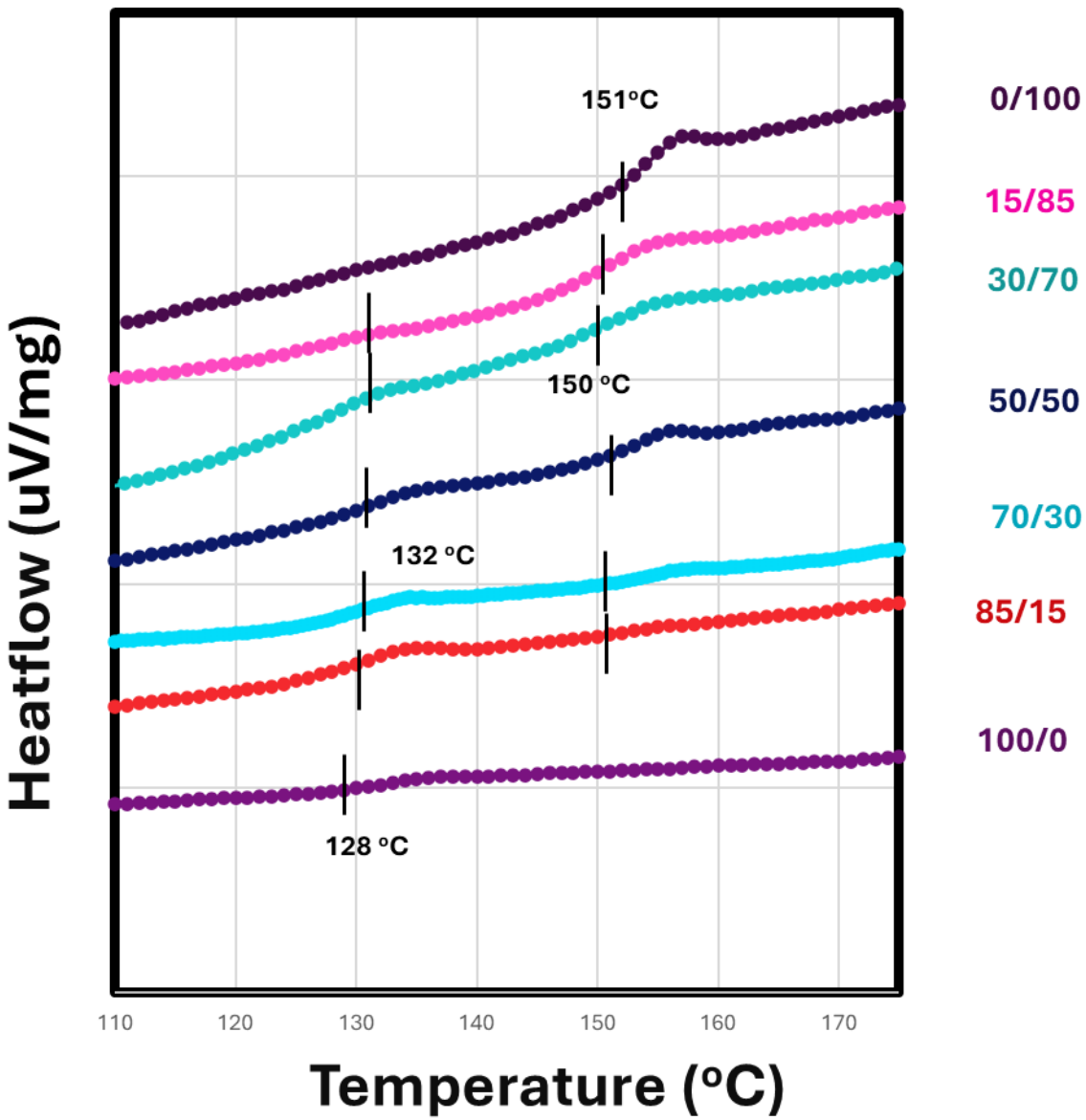
- There is a single glass transition temperature in blends with PC content ≤15 %, indicates the blend is miscible.

- Two distinct glass transition temperatures appear in blends with PC content > 15 %, indicating partly miscibility.



RESULTS PMMA1083K /PC

- Two distinct transitions are showed in all blends, indicating two components are completely immiscible.



SUMMARY

- The glass transition and miscibility of polycarbonate (PC) with poly(methy1 methacrylate) (PMMA) has been examined using differential scanning calorimetry (DSC).
- The Solution casting method has been used to prepare the blends with methylene chloride (CH_2Cl_2) as solvent.
- It is shown that the miscibility for PC/PMMA blends is strongly affected by the molecular mass and composition of PMMA.

Blends	Miscibility
PMMA4K/PC	Miscible over the whole composition range
PMMA50K/PC	Partly miscible depending on the composition
PMMA221K/PC	Partly miscible depending on the composition
PMMA1083K/PC	Immiscible at any compositions

ACKNOWLEDGMENTS

- GUANGCUI YUAN
- MALIA WENNY, JUSCELINO LEAO, TANYA DAX, DONNA KALTEYER
- JULIE BORCHERS, SUSANA TEIXEIRA, LELAND HARRIGER
- SURF AND CORE INTERNS

'The Center for High Resolution Neutron Scattering (CHRNS) is a national user facility jointly funded by the NIST Center for Neutron Research (NCNR) and the National Science Foundation (NSF) under Agreement No. DMR-2010792.'