

DEVELOPMENT OF A NEW POLYMER GLASS FOR CULTURAL HERITAGE WITH ENHANCED ABRASION RESISTANCE

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Introduction

PMMA is used by many artists to produce artworks. It is also widely applied in conservation for the framing to protect artifacts during exhibitions and especially travelling exhibitions.

Unfortunately PMMA is very sensitive to abrasion and after few years, the visual appearance of the artwork is impacted. To improve the PMMA properties, protective coatings have been implemented (such as anti-scratching, anti-UV, anti-reflects etc.) but the price make it unaffordable for many museums and artists.

PMMA has already been combined with other polymers by copolymerization.

An other way consists to combine PMMA with other polymers in a Interpenetrating Polymer Networks (IPN) architecture

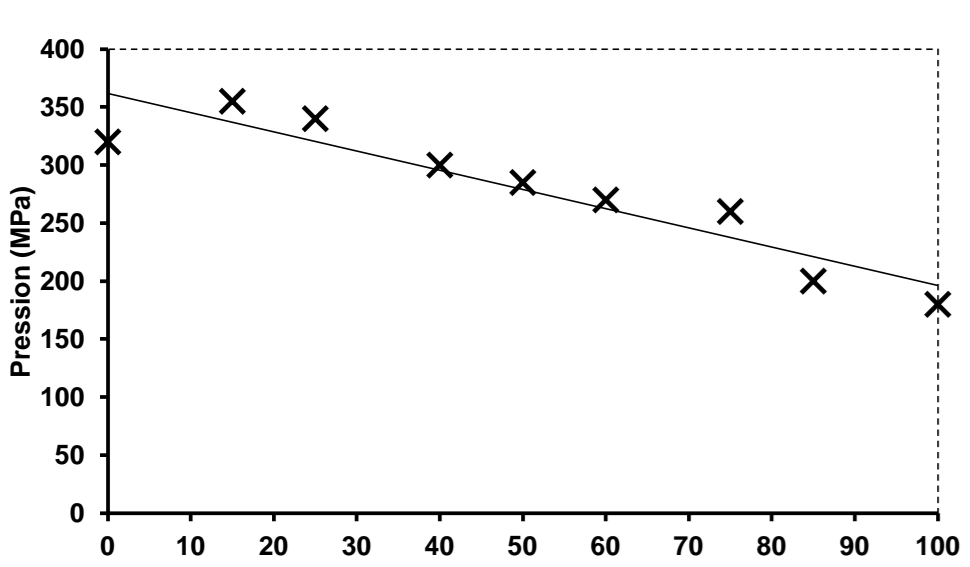
This embodiment allows obtaining :

- dimensional stability
- forced miscibility
- combination of properties of associated polymers

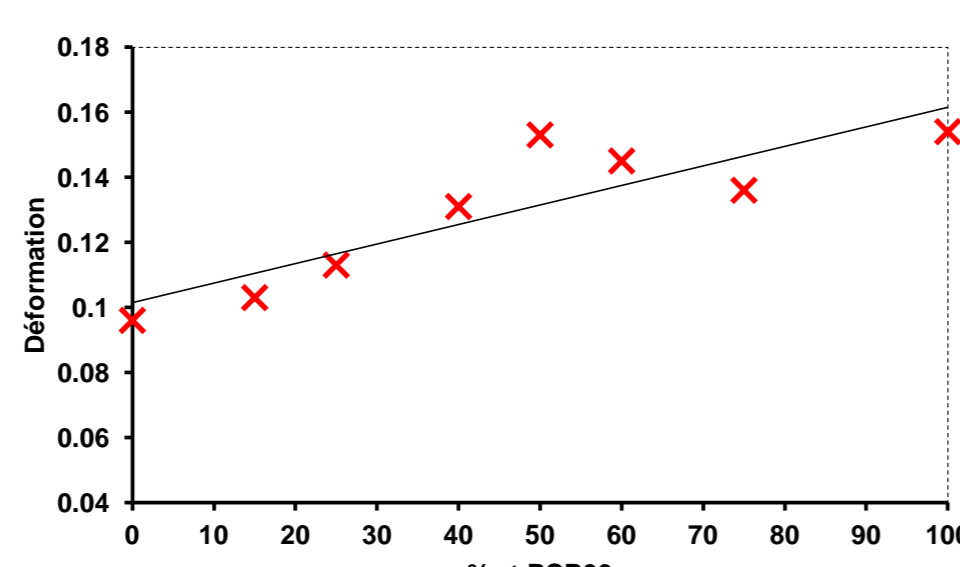
The selected strategy is to associate polycarbonate (PCR39[®]) to enhance the PMMA properties in a one block polymer glasses.

Characterizations

Scratch resistance : performed with a sclerometer « Micro-Visio-Scratch »



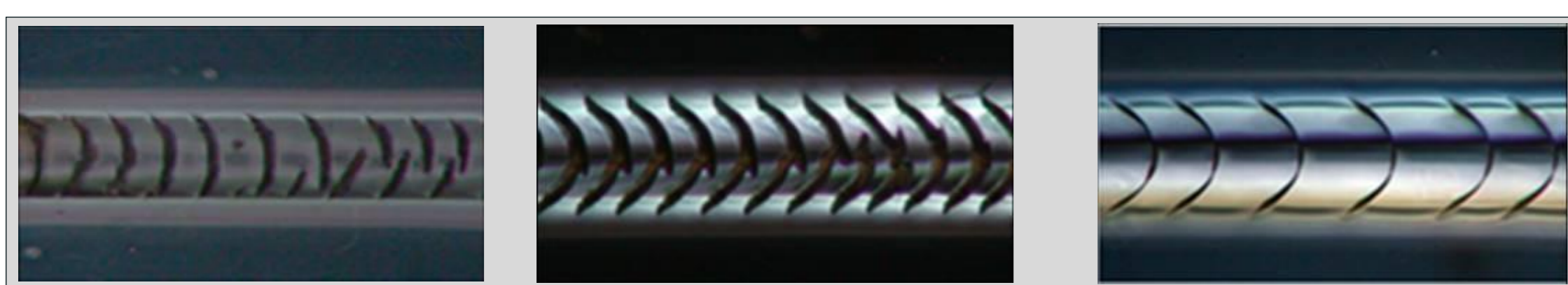
The **limit pressure** decreases with increase of PCR39[®] ratio



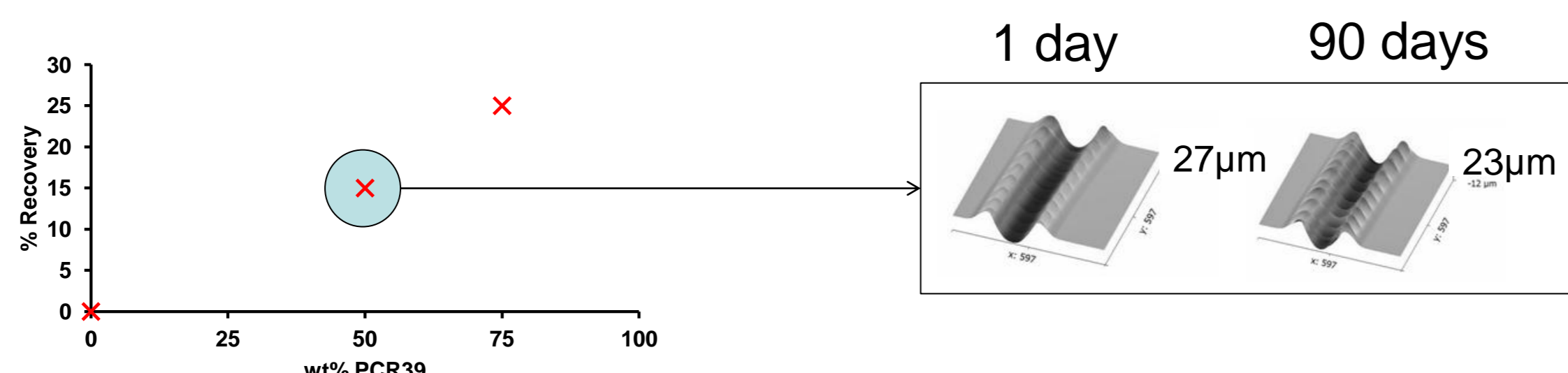
The **limit deformation** increases with increase of PCR39[®] ratio

➔ Improvement of the scratch resistance by adding PCR39[®]

Damage analysis and Analysis of the scratch recovery :

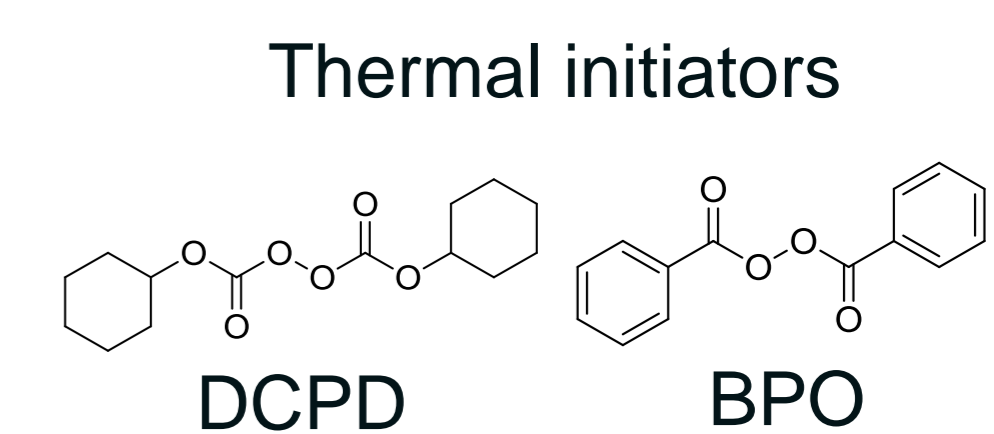
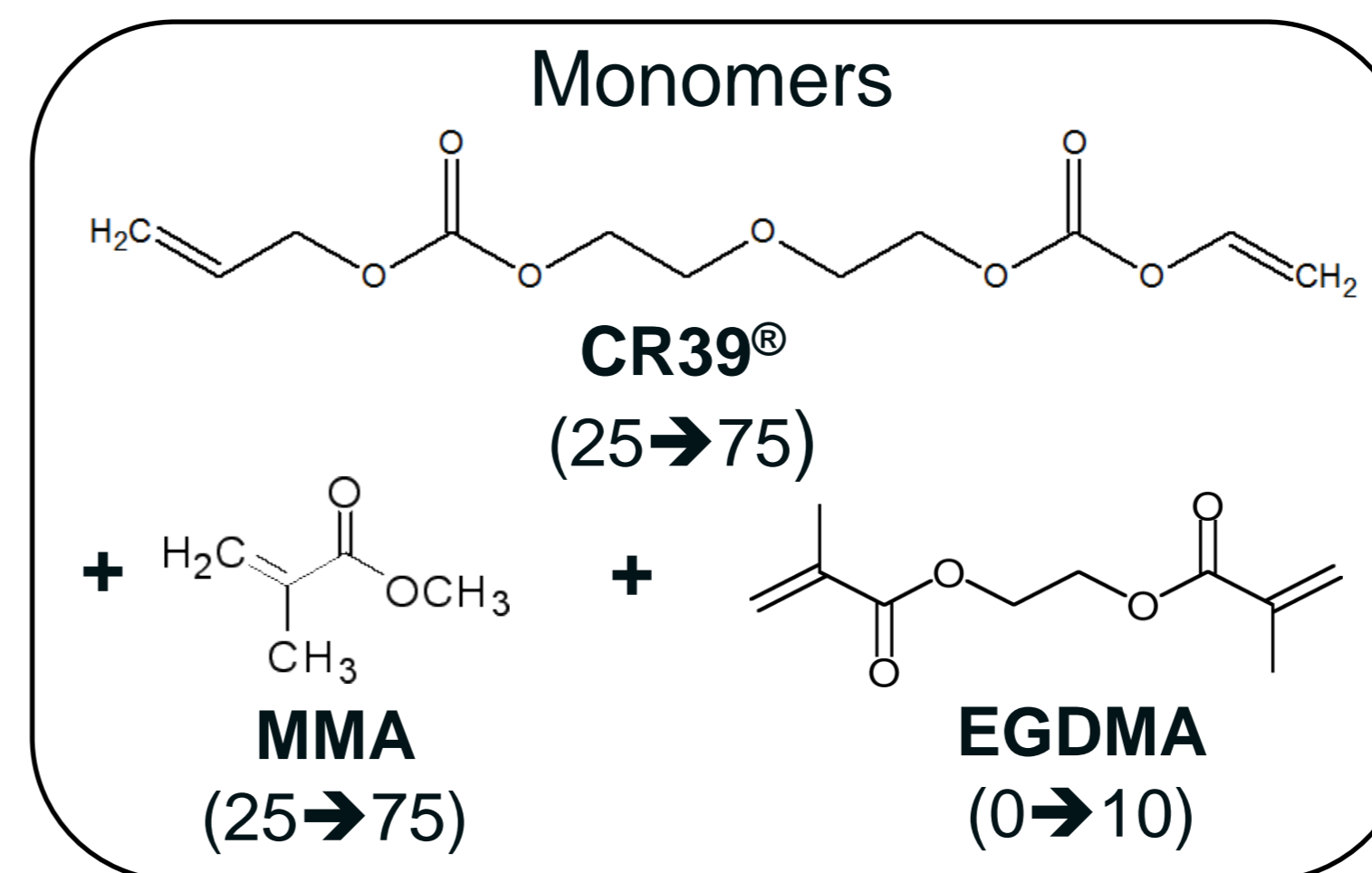


➔ Combination of the damage mechanisms in the IPN

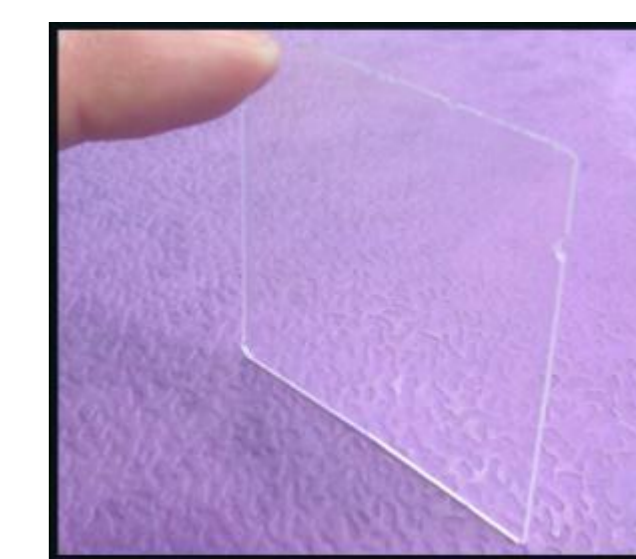


➔ Introducing PCR39[®] provides **scratch recovery properties**

Synthesis

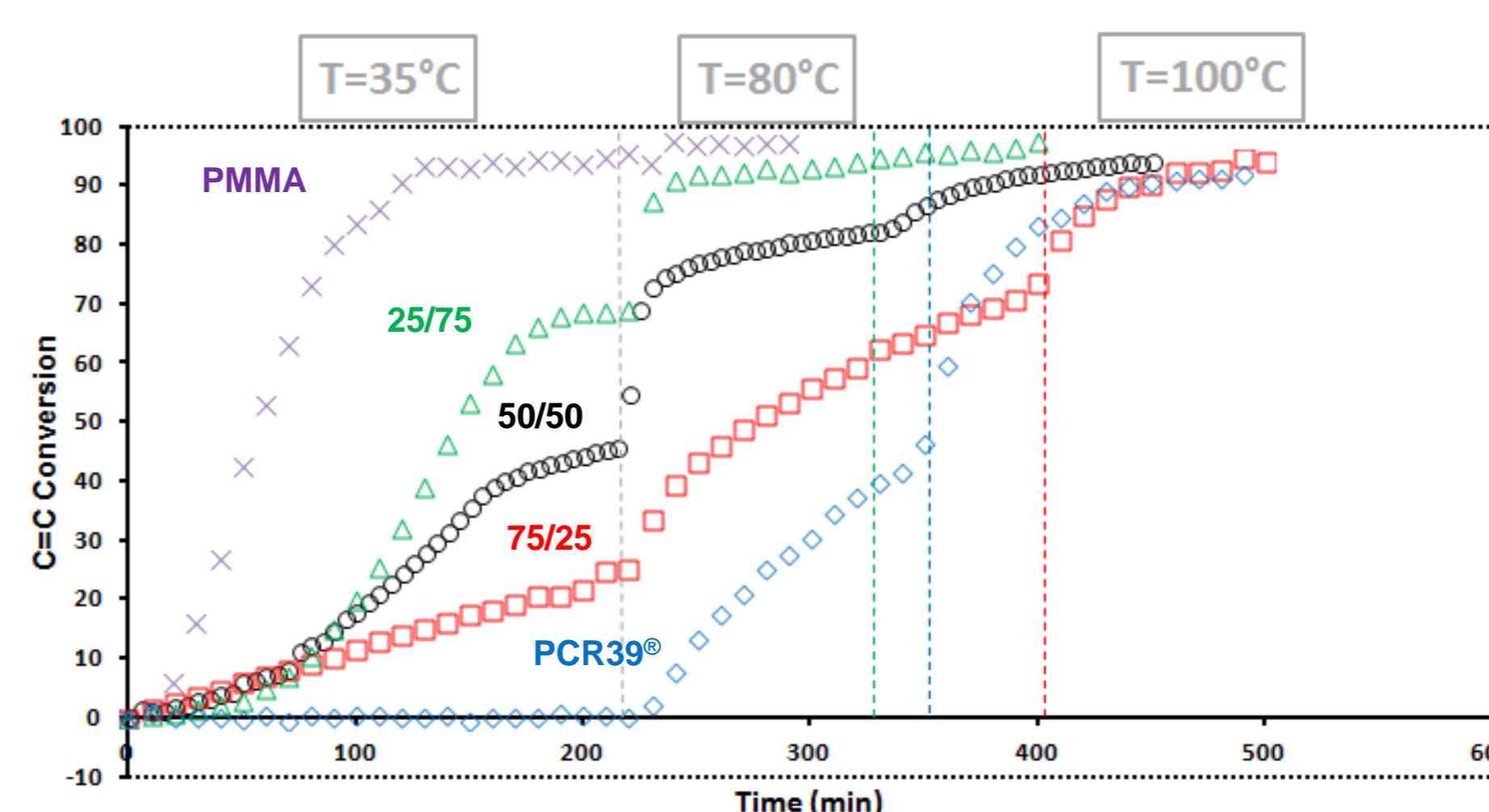


3h30 at 35°C, 2h at 80°C, and 1h à 100°C



Network formation

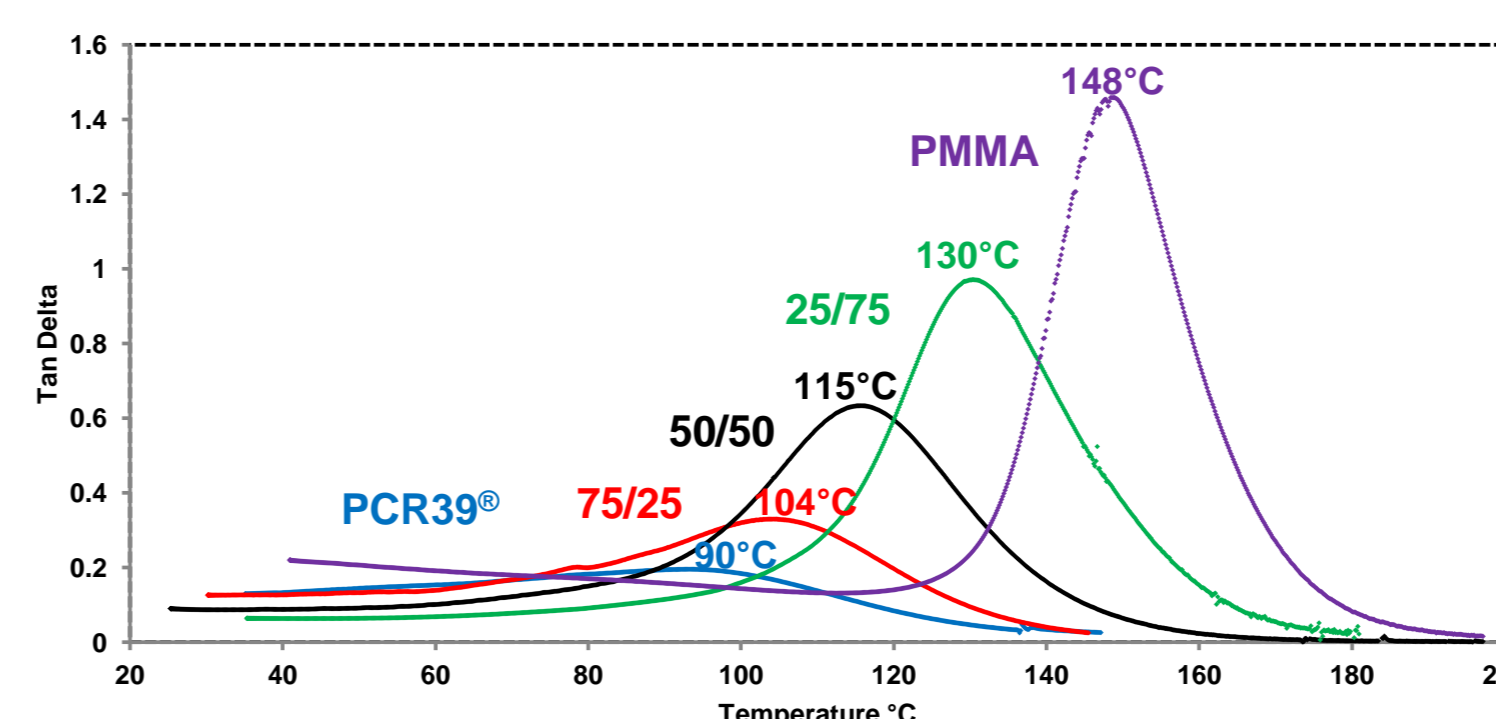
Followed by FTIR spectroscopy in the Near IR



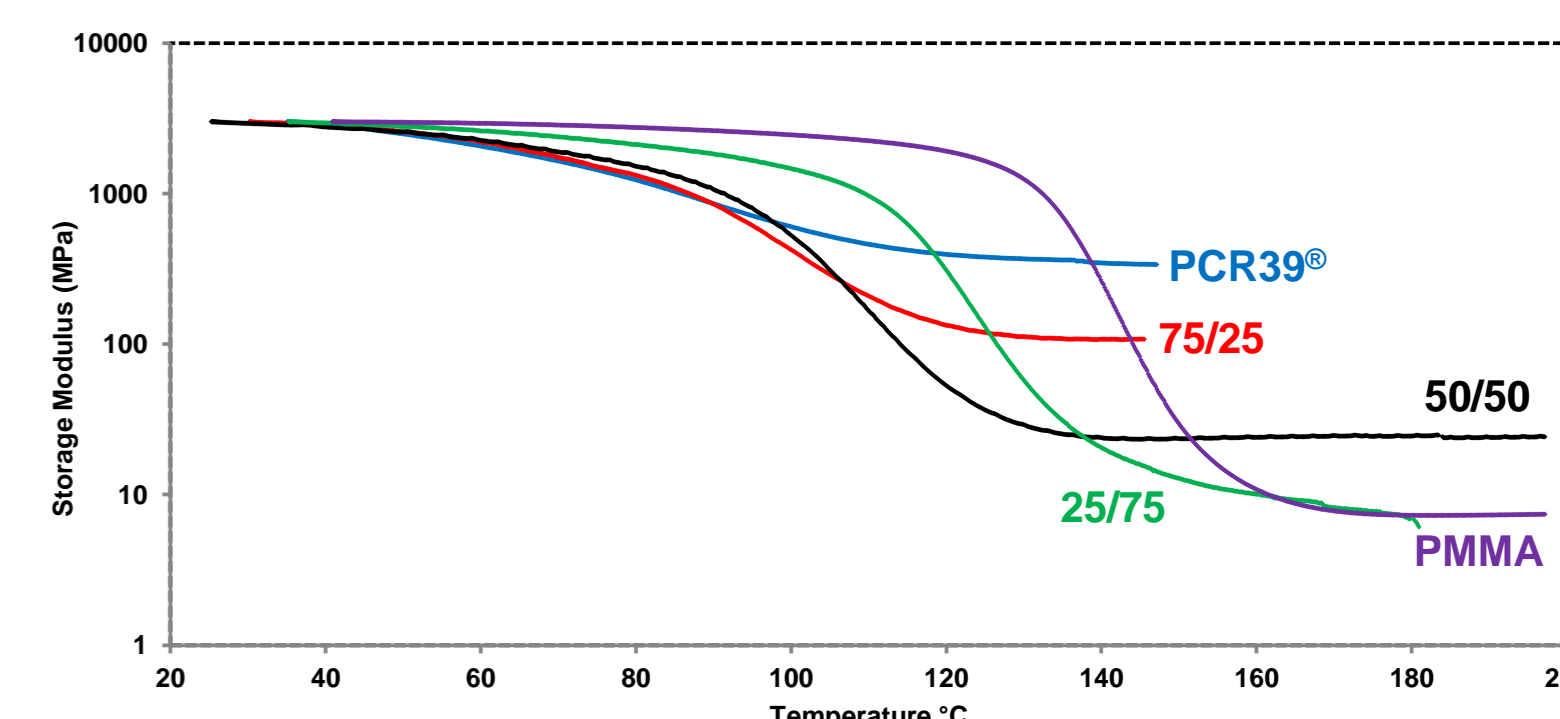
- ➔ *In situ* sequential synthesis
- ➔ Total conversion of monomer
- ➔ Soluble fraction < 1%
- ➔ Correct crosslinking of polymers
- ➔ Transparent materials

ThermoMechanical properties

Performed at 1Hz, 3°C/min



Only one peak detected :
➔ Correct **interpenetration** of both networks

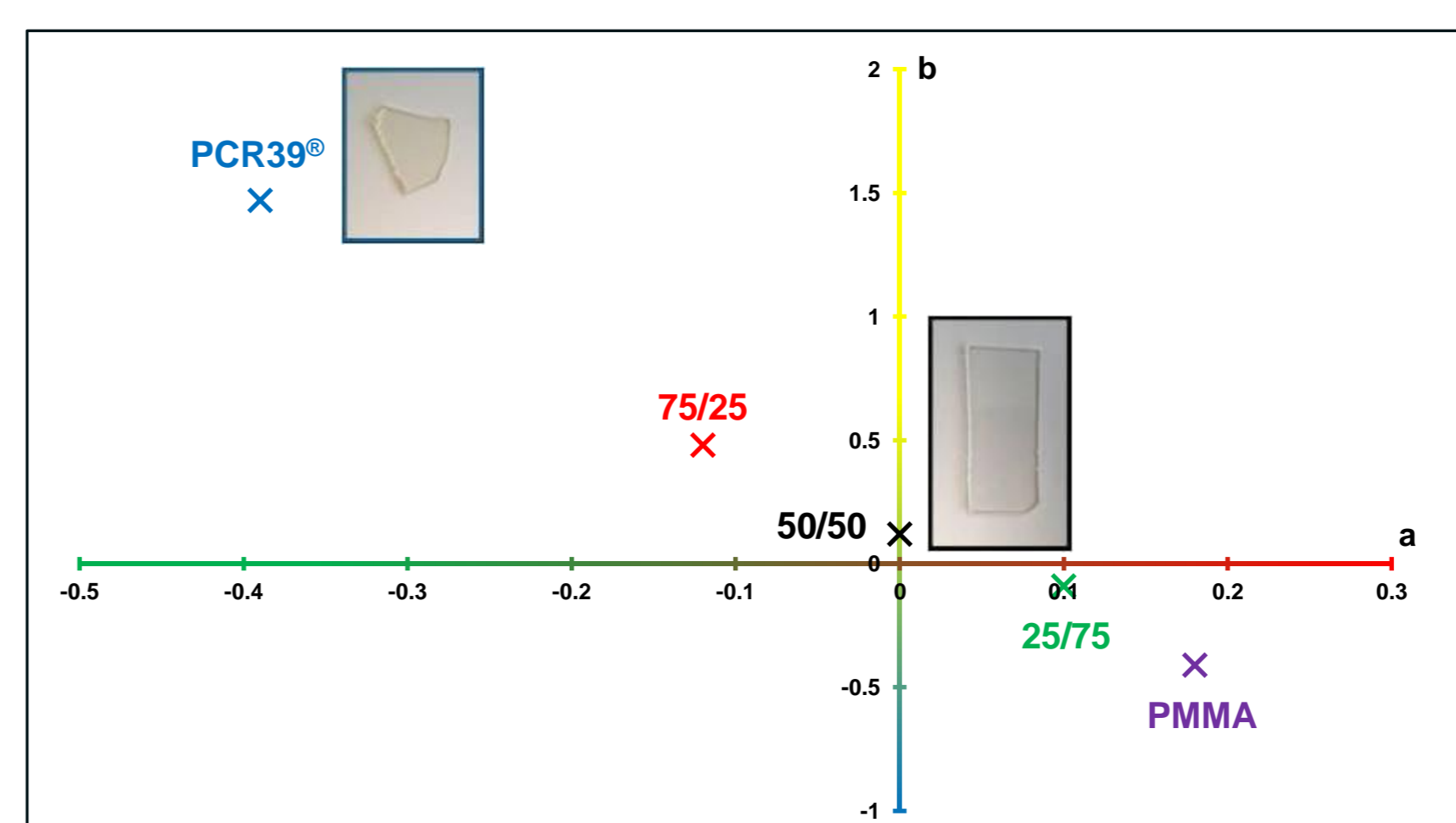


Storage modulus of IPNs between those of PMMA an PCR39[®] networks
➔ Morphology of phase **co-continuity**

Artificial ageing test :

Ageing conditions : 50°C, 100% Relative Humidity, 21 days

Analysis performed with a Colorimeter : measure of the L,a and b coefficient



➔ **No yellowing** observed with IPNs compared with PCR39[®]

Conclusions

- Synthesis of a new material : PCR39[®]/PMMA IPN with different compositions
- Mechanical surface properties enhanced compared to those of PMMA such as new properties of recovery
- Advantages of PCR39[®] without its drawbacks (yellowing)

Work in progress

- Use of nanoparticles to enhance the abrasion resistance
- Development of an UV sensor embedded in the glass

Acknowledgment

- We thank the PATRIMA foundation for financial support