Fabrication and Evaluation of Polyurethane Nanocomposites with Plasma-Modified Carbon Nanotubes

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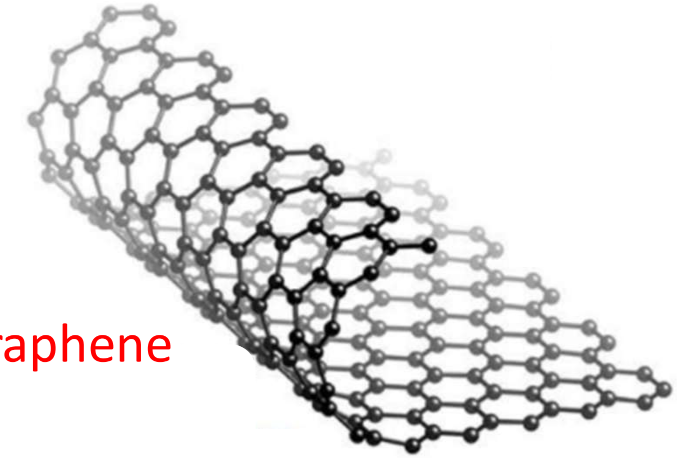
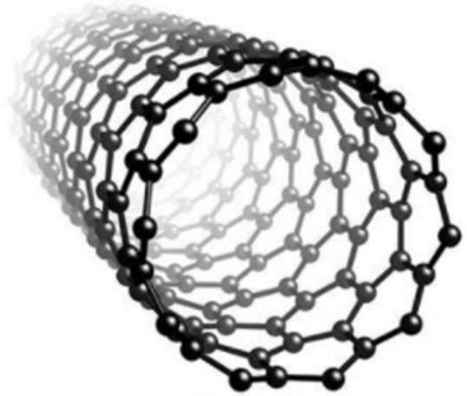
Introduction

Nanocarbon: nano-sized carbon material



Graphene



Carbon nanotubes

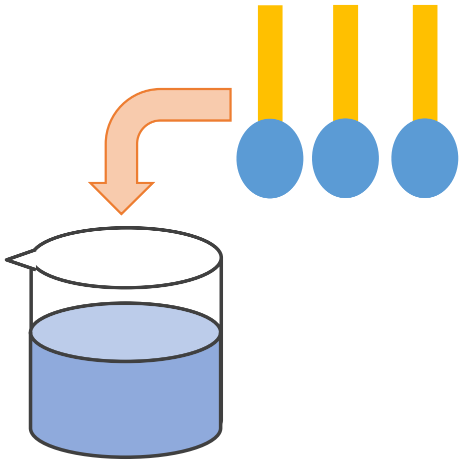
High thermal conductivity and mechanical strength

However

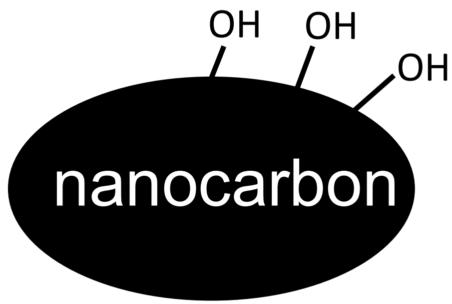
・Strong van der Waals forces, easy to aggregate

・Poor interfacial interaction

Introduction



Improved dispersibility



Surfactants

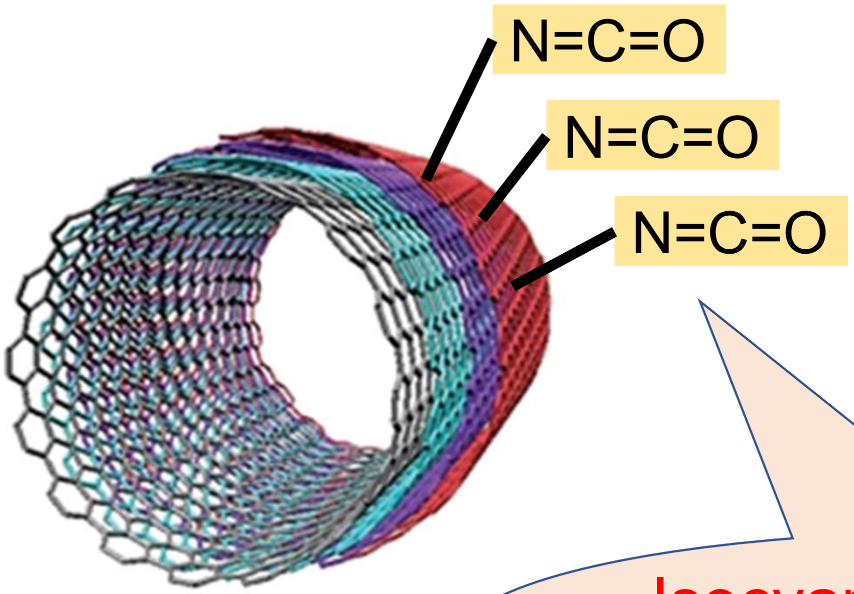
Physical properties are difficult to increase

Chemical modifications

Complicated process
Too much filler loss

Introduction

Surface modification by plasma treatment



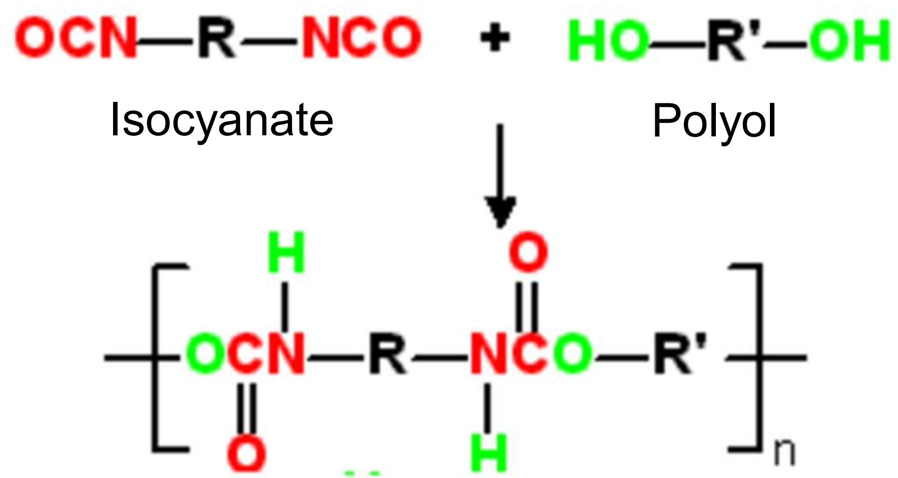
Simple process
low loss

Isocyanate groups are imparted by plasma

Plasma treatment Carbon nanotubes(pCNT)

Daisuke Ogawa Laboratory, Department of Electrical and Electronic Engineering

Introduction

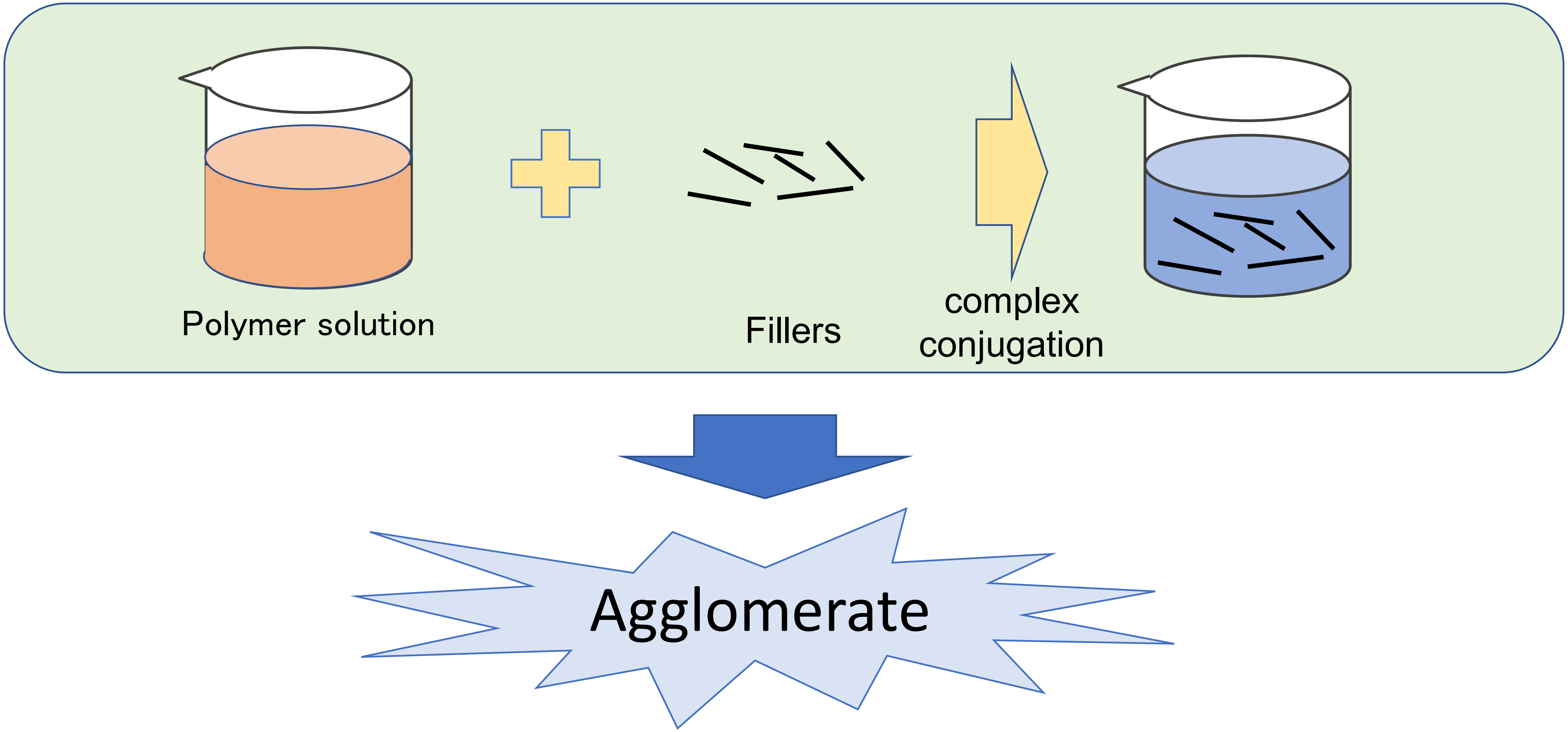


pCNTs + Polyurethanes(PU)

Fabrication of polyurethane composites

Introduction

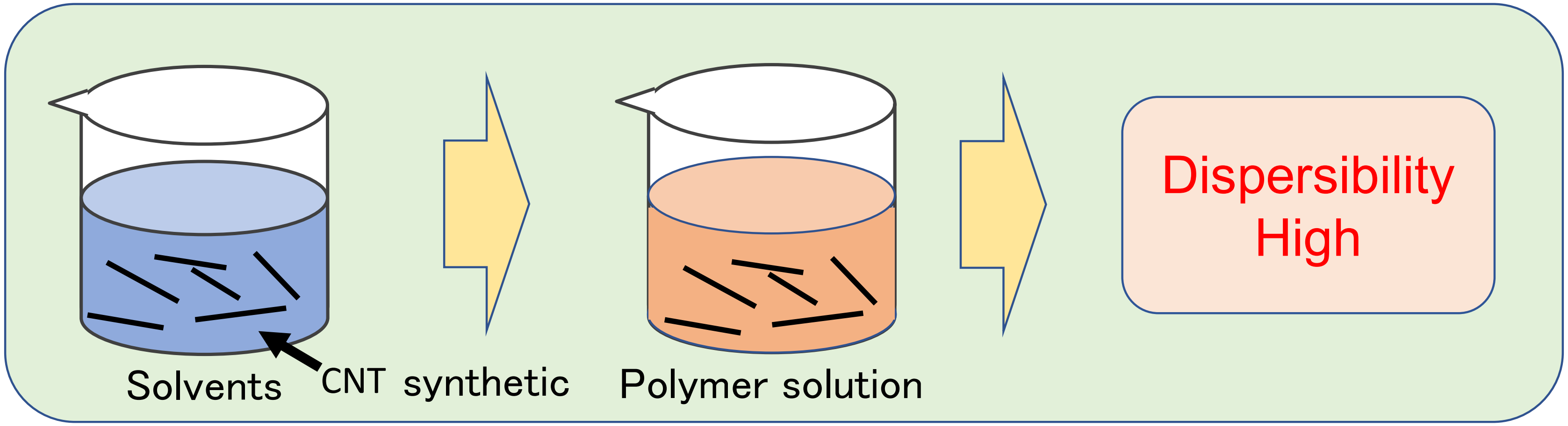
solution mixing method



Introduction

This study

In-situ polymerization



Matrix: Polyurethane (PU)

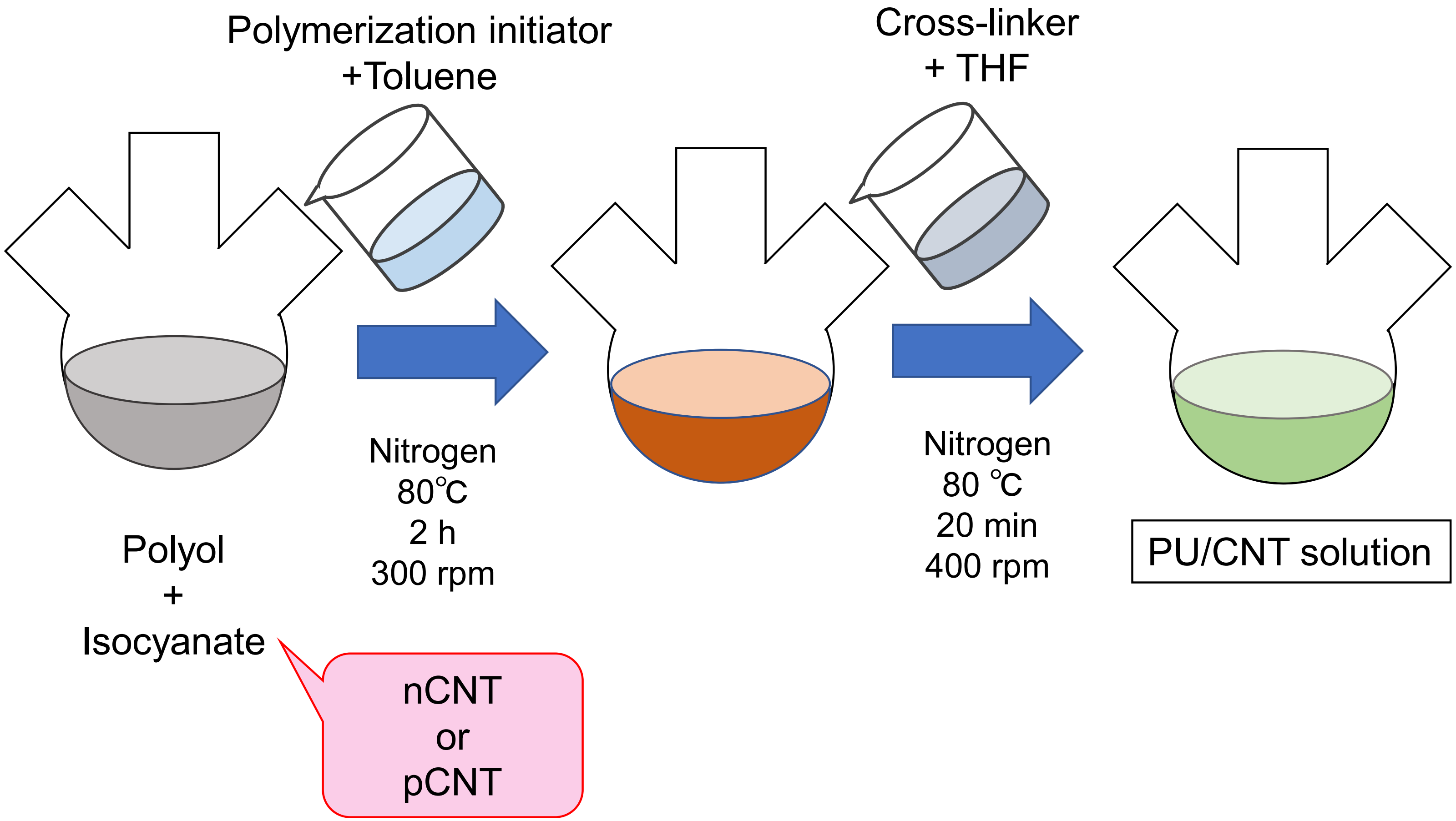
Filler: Carbon nanotubes (CNT)

PU/CNT Composites

Sample Preparation

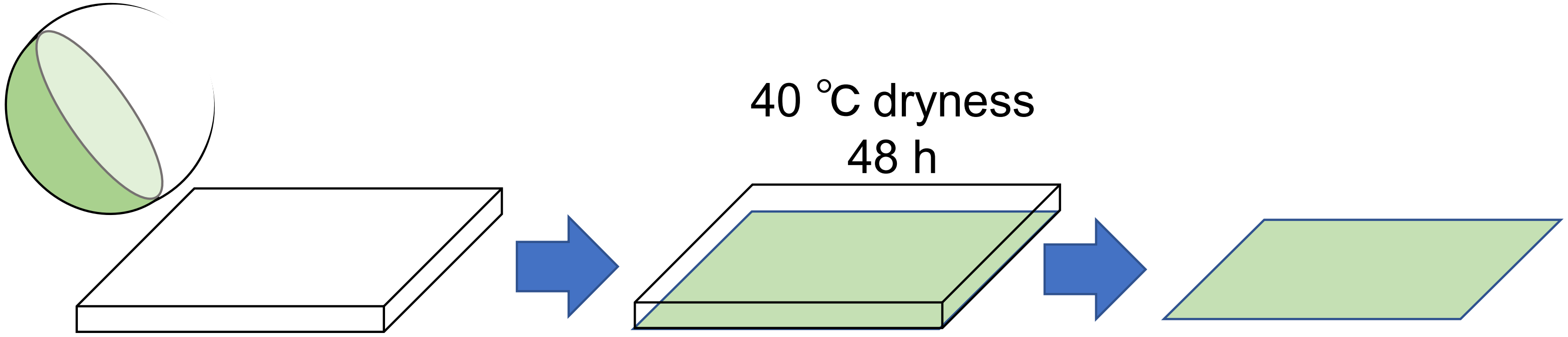
Synthesis of PU/CNT composites

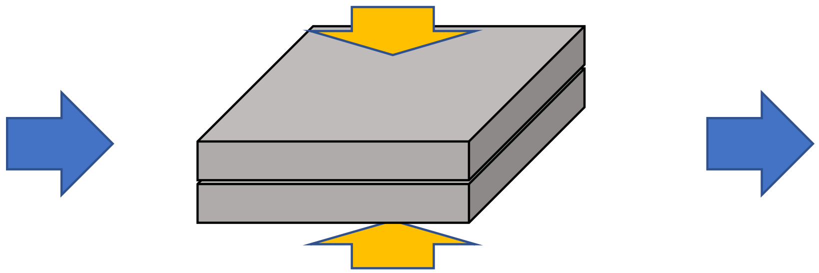
Polyol: Polytetramethylene oxide
Isocyanate: Hexamethylene diisocyanate



Sample Preparation

Polyurethane molding





170 ℃

Melt Press Forming

PU/CNT composite materials

CNT Fill Rate

extremely small quantity : 0.01 wt% or 0.02 wt% or 0.03 wt%

small quantity : 0.1 wt% or 0.3 wt% or 0.5 wt%

Approx. 200 µm

Results & discussion

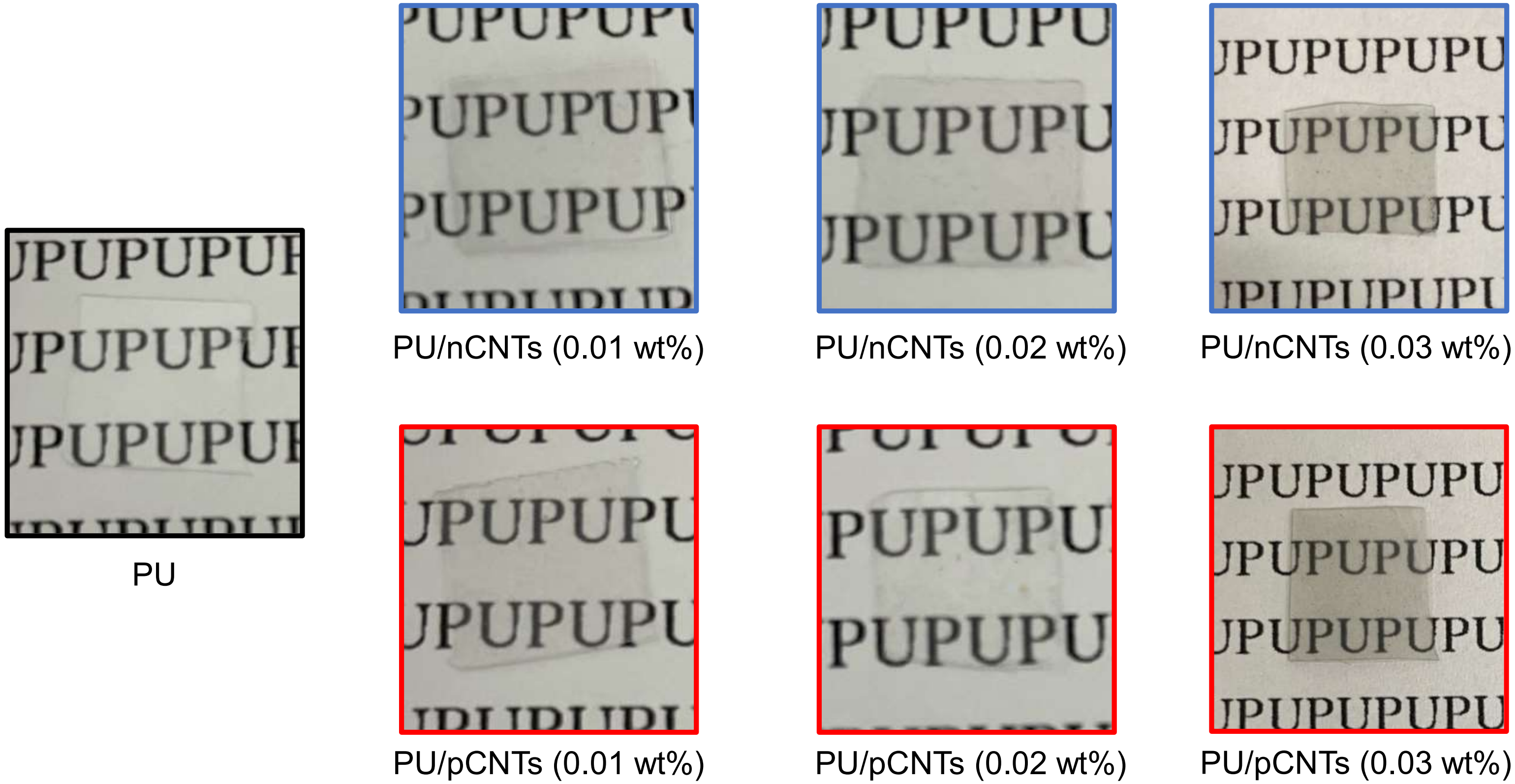
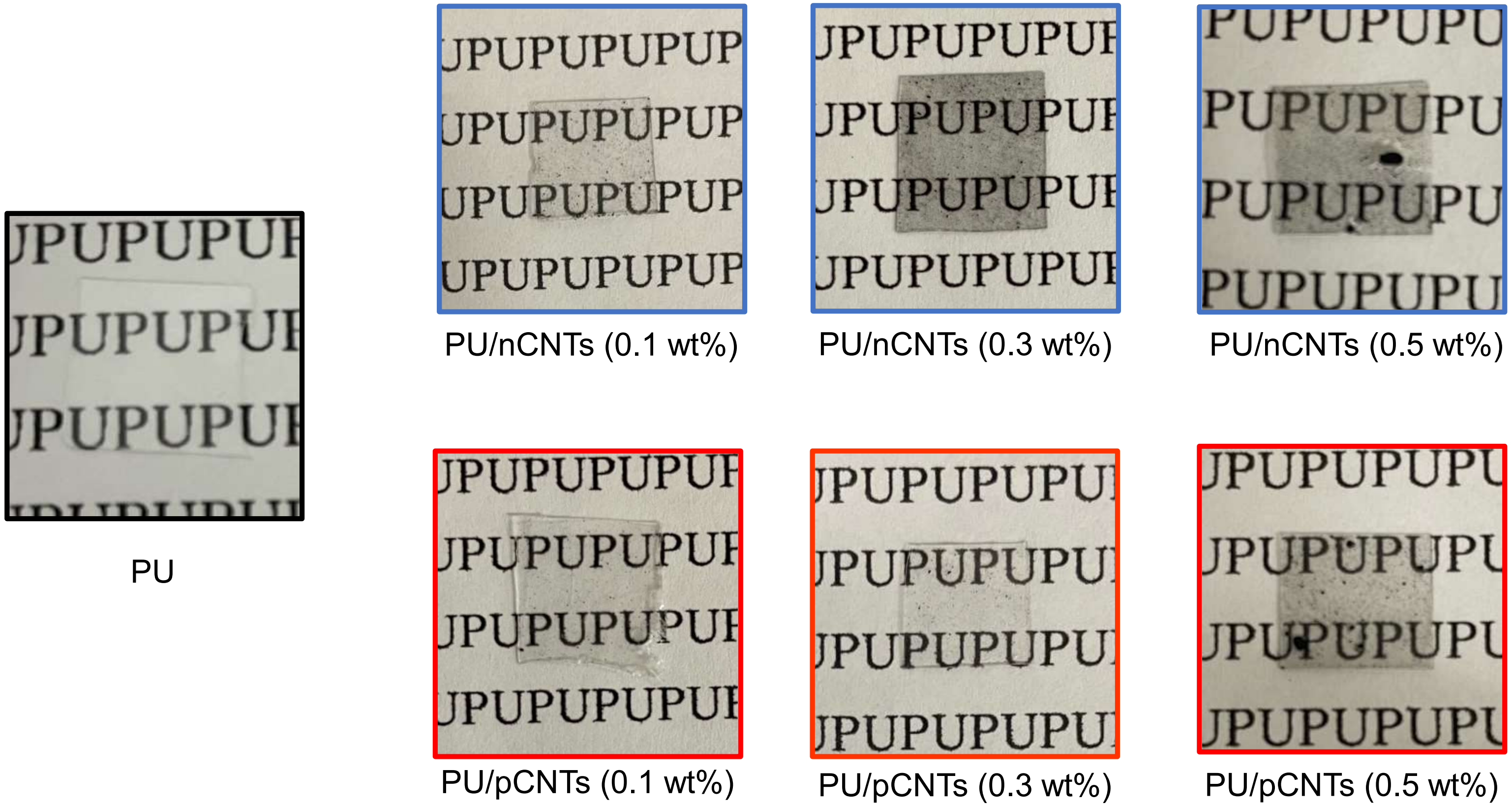


Figure Optical images of PU and various PU/CNTs nanocomposites

Results & discussion



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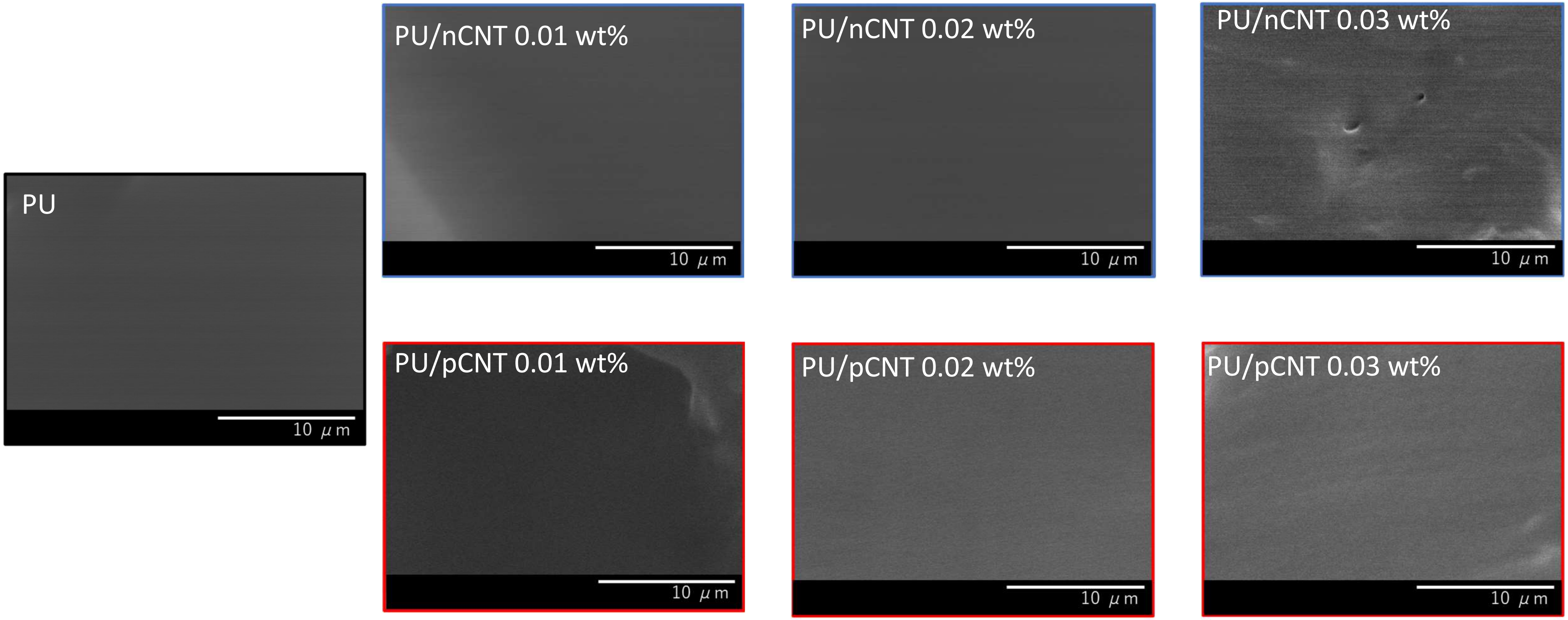
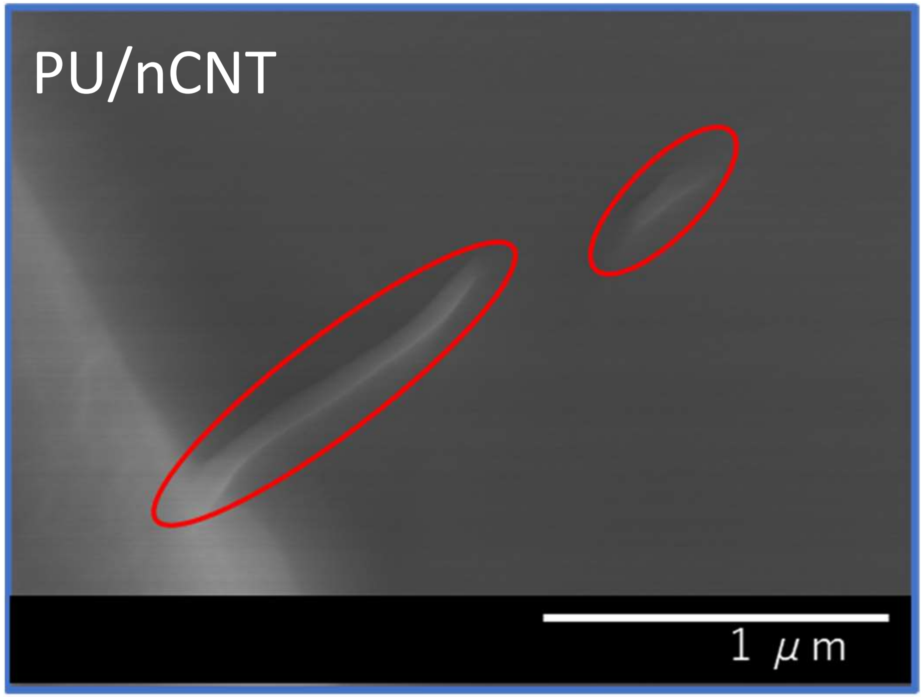
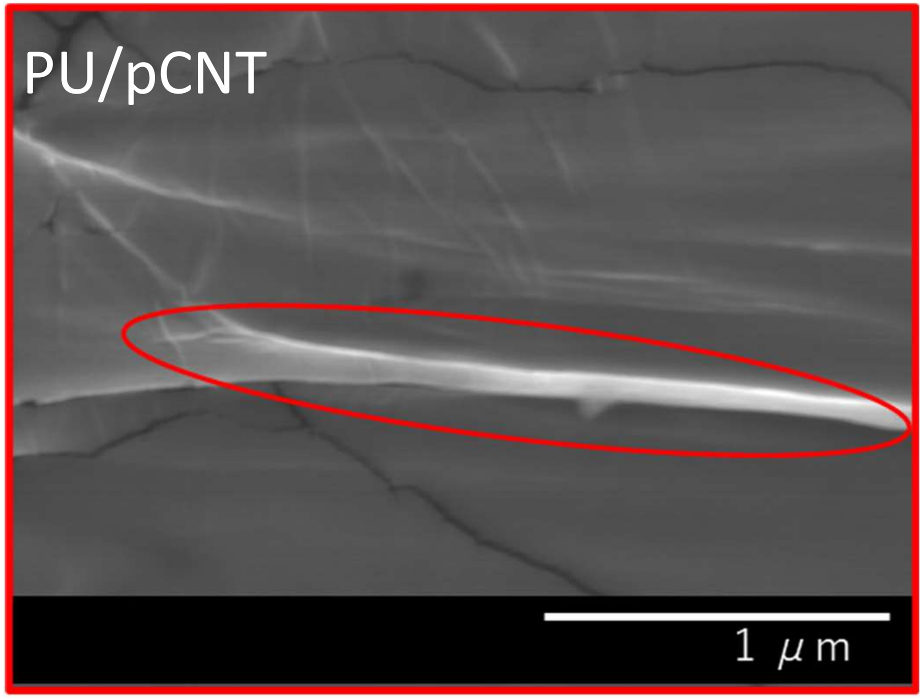


Figure. SEM images of PU and PU/CNT composite materials

Results & discussion





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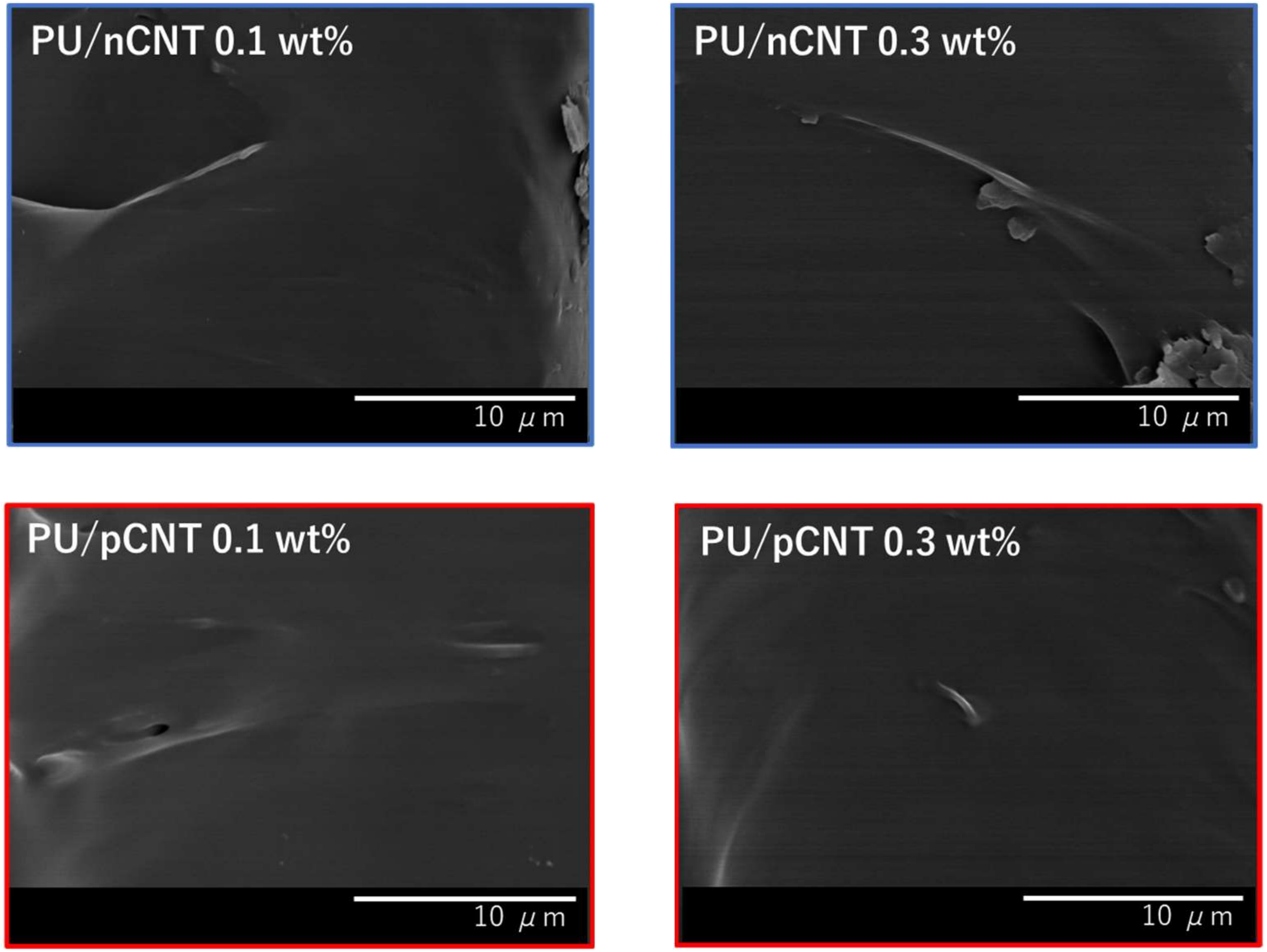

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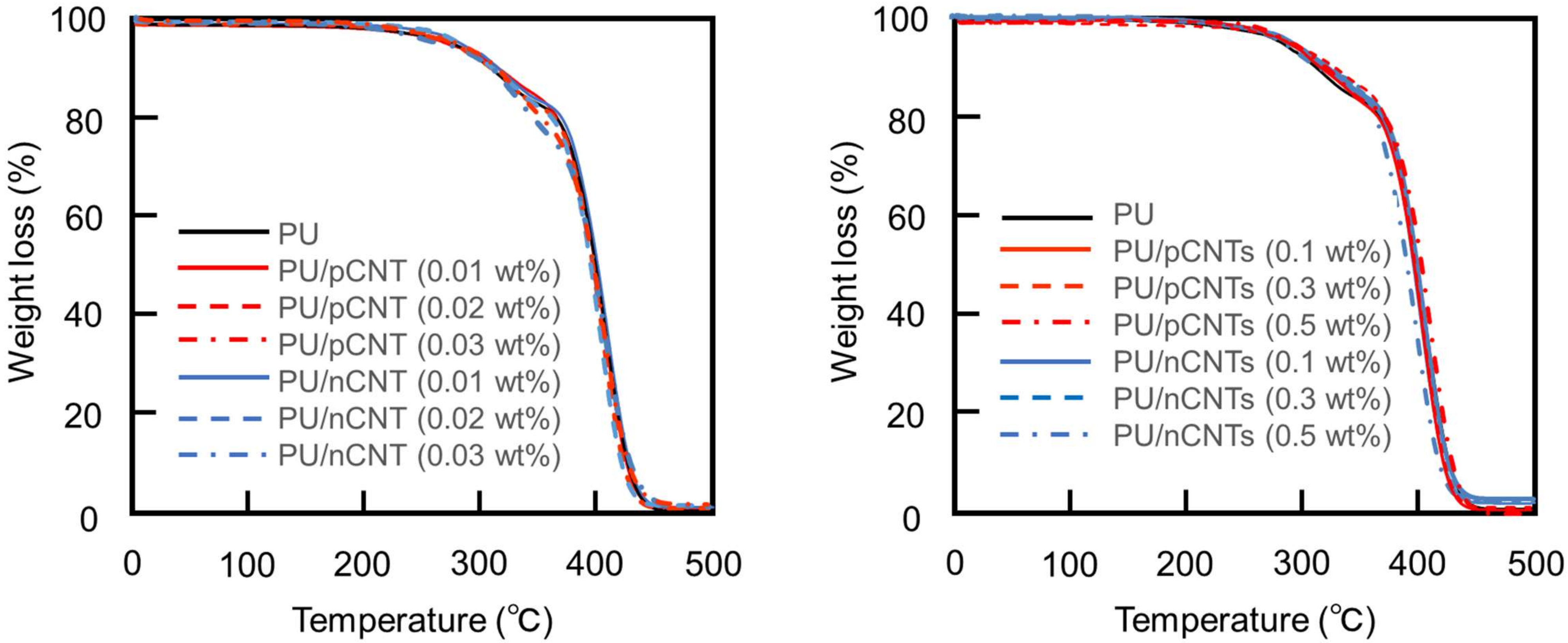

Figure. Thermogravimetric curves of PU and PU/CNTs nanocomposites

Results & discussion

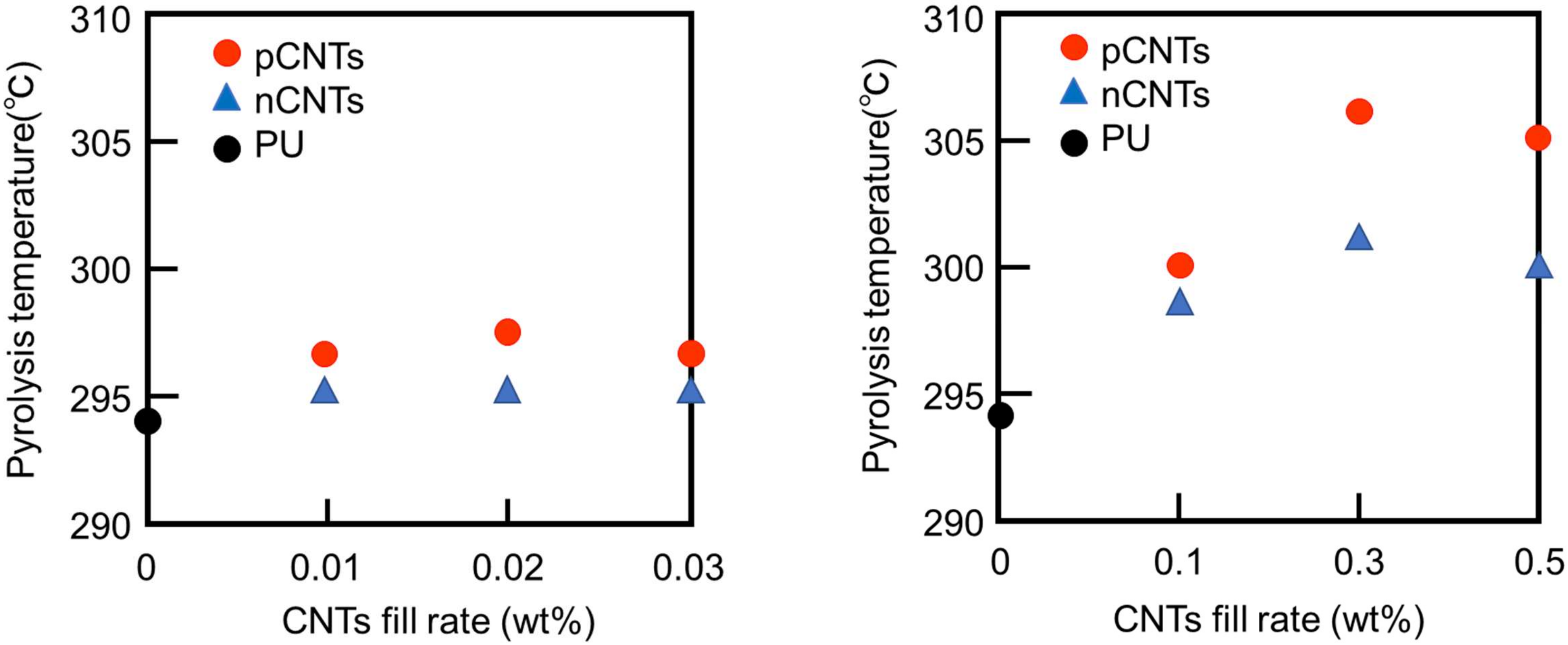

Figure. Pyrolysis temperatures of PU and PU/CNTs nanocomposites

Results & discussion

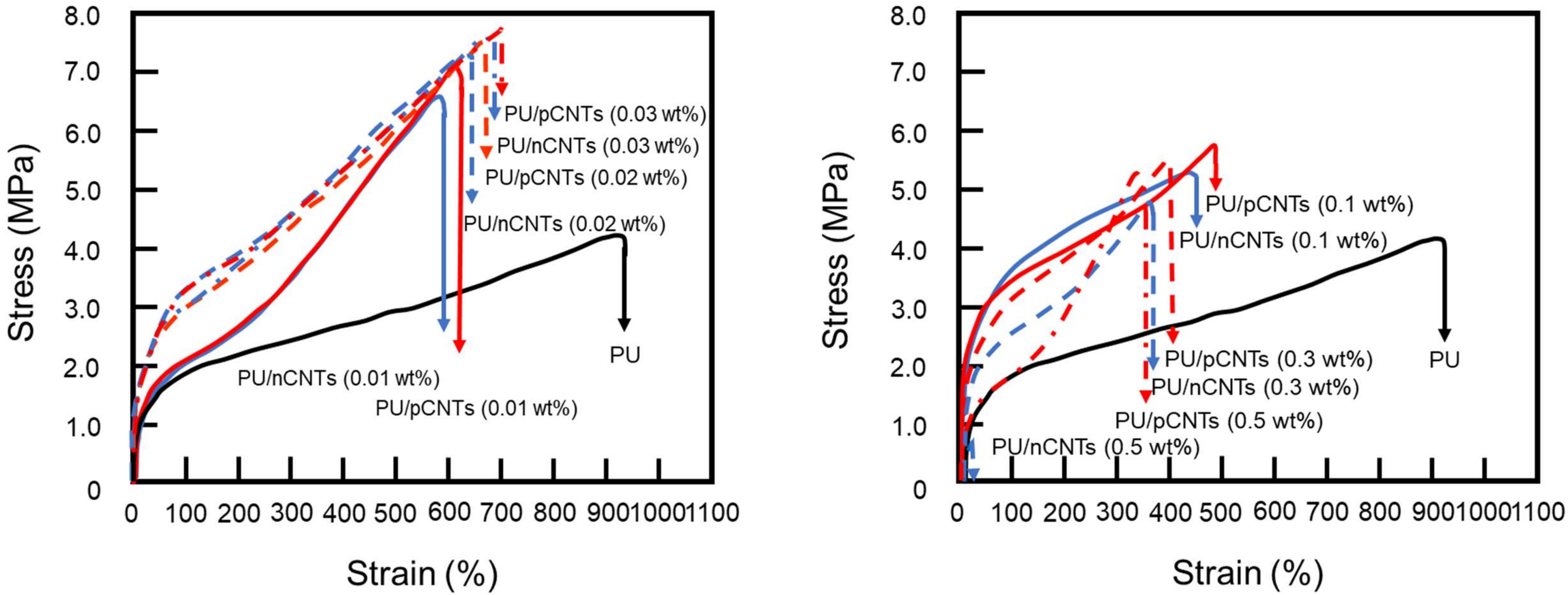

Figure. Stress-strain curves of PU and various PU/CNTs nanocomposites

Results & discussion

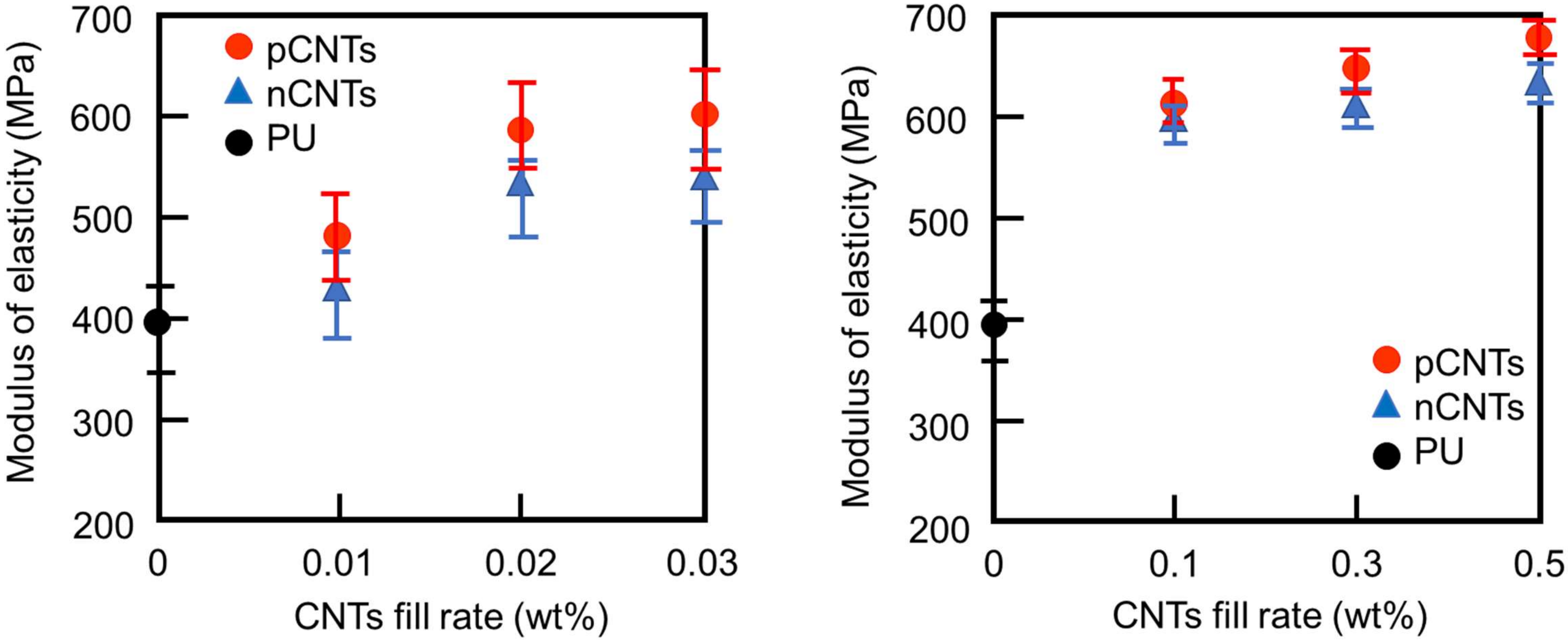

Figure. Elastic modulus of PU and various PU/CNTs nanocomposites

Results & discussion

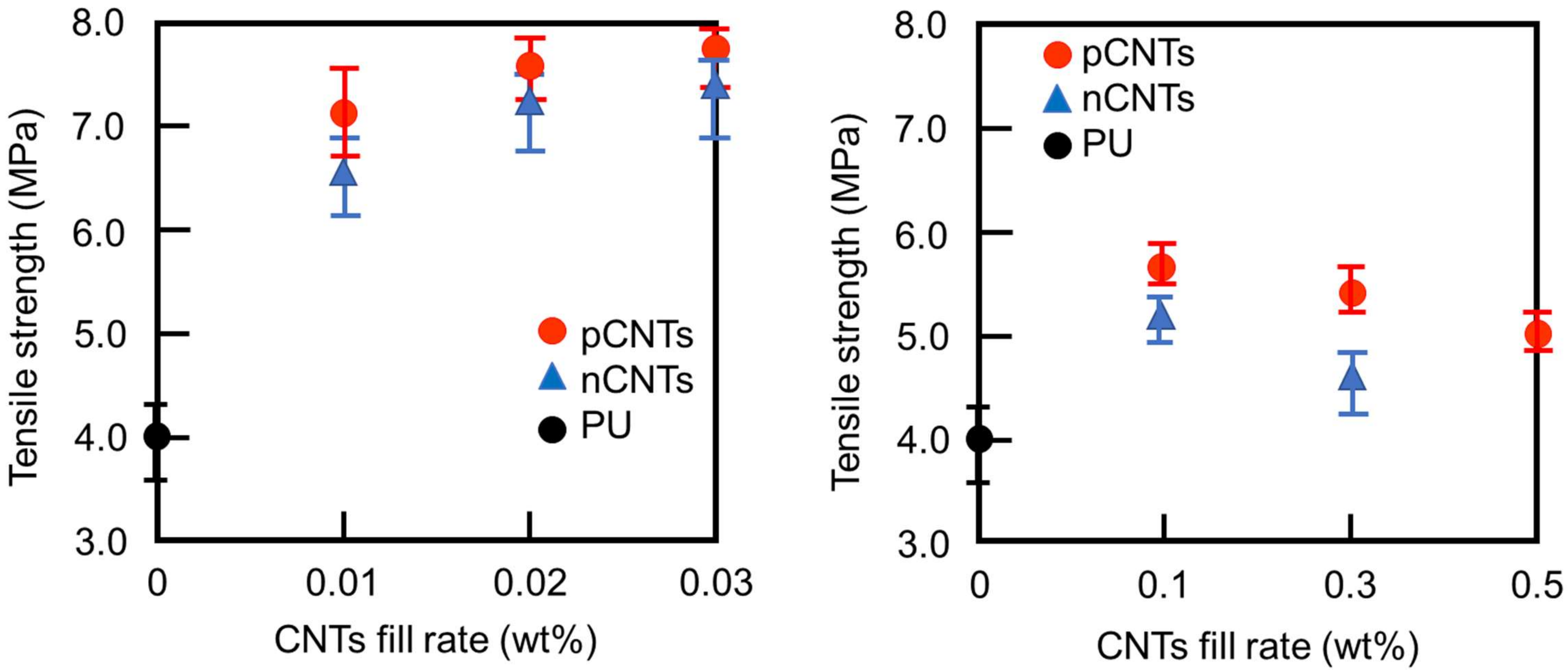

Figure. Tensile strength of PU and various PU/CNTs nanocomposites

Results & discussion

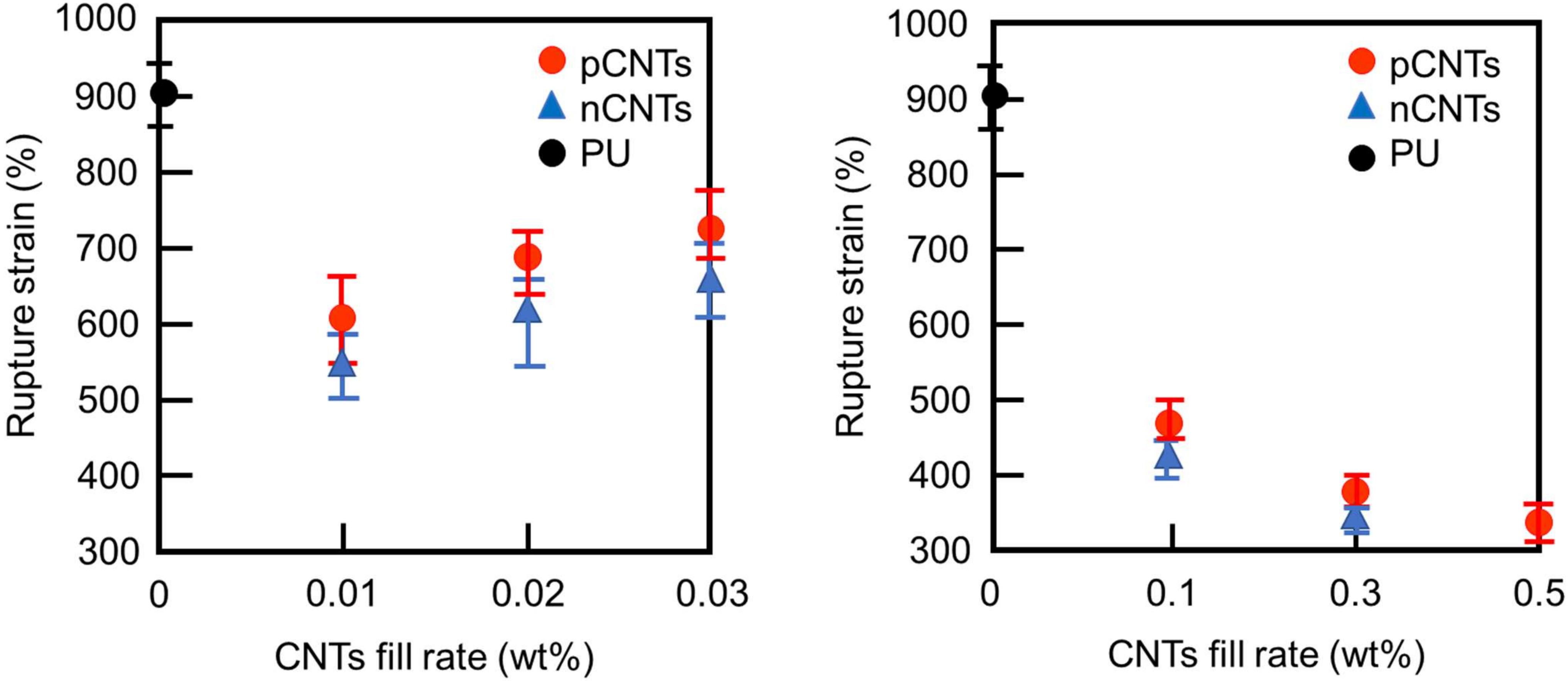

Figure. Fracture strain of PU and various PU/CNTs nanocomposites

Results & discussion

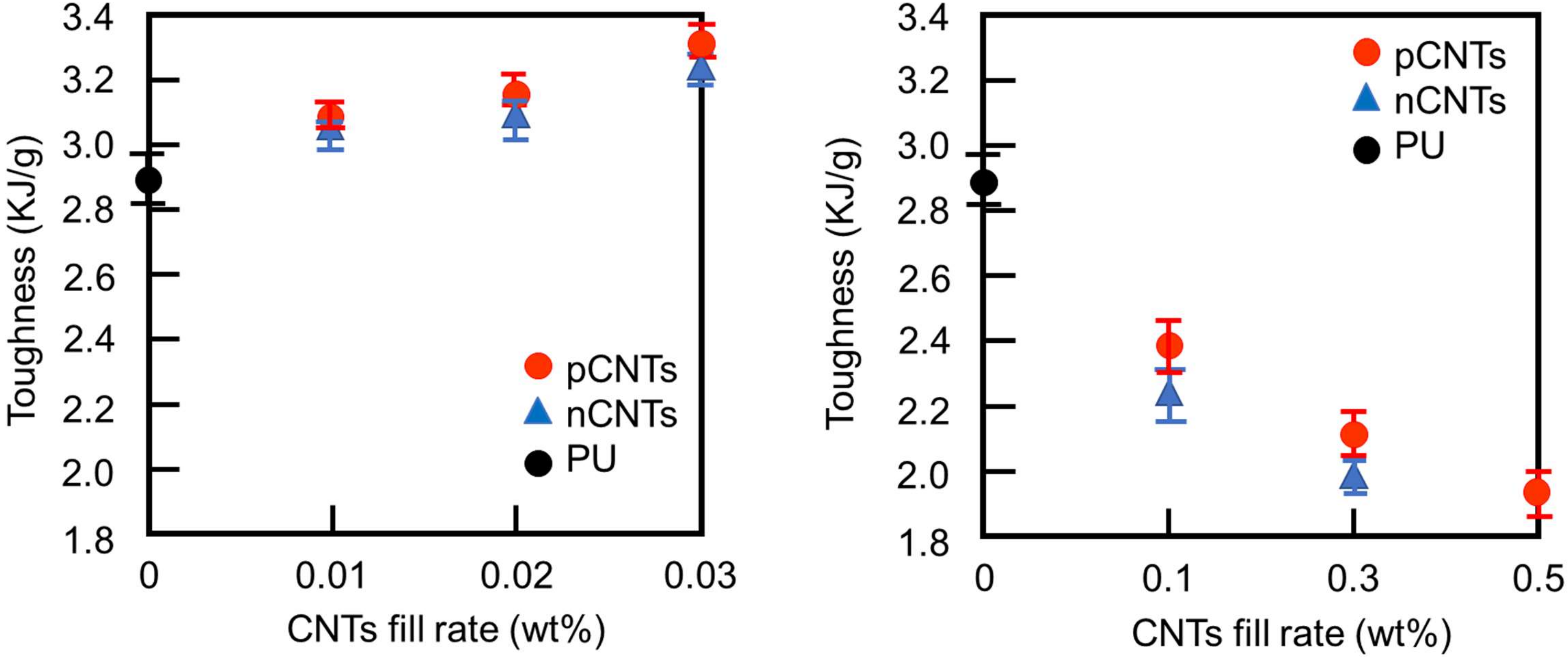

Figure. Toughness of PU and various PU/CNTs nanocomposites

Conclusions

In very small quantities, the film maintained transparency, but in smaller quantities, agglomerates were seen.

Thermophysical properties showed a high rate of increase for small volume fills.

In terms of mechanical properties, both elastic moduli showed a high rate of increase, while other properties showed a high rate of increase for very small volume fillings.

Thank you for your attention.