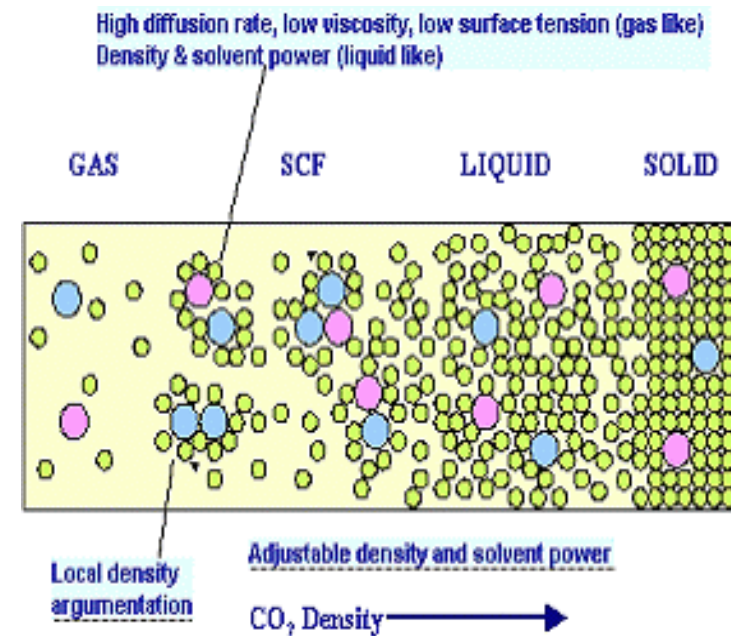
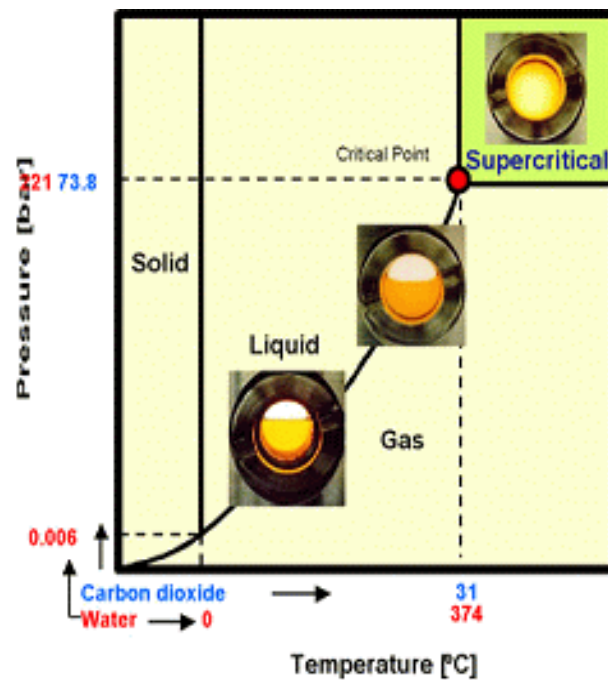


## Development of A New Processing System with Power Ultrasound and scCO<sub>2</sub> for Polymer Blends

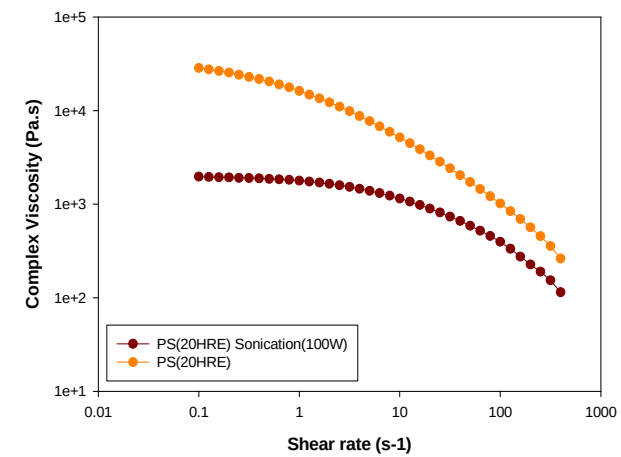
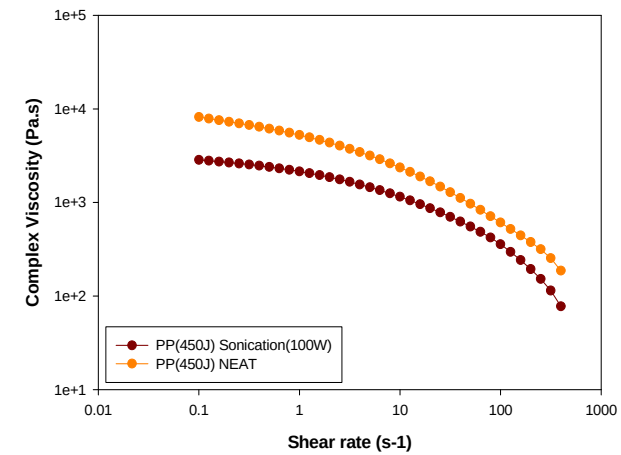
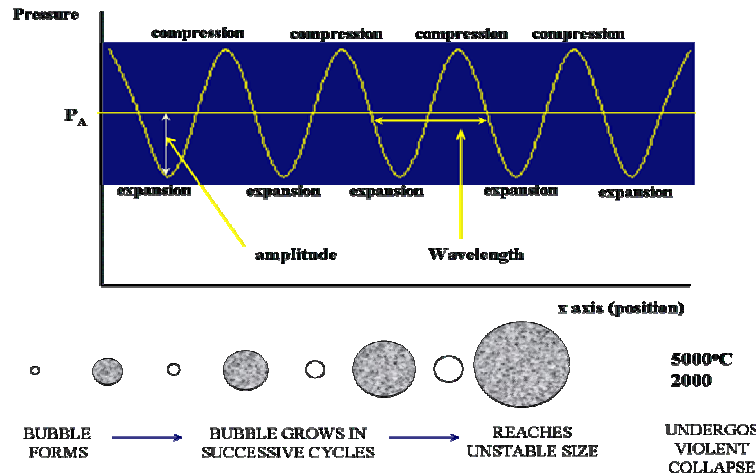


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## ● Supercritical fluid define & properties



## Degradation of polymer under sonication



## Materials

### Polymer

● Polypropylene (HP450J, Polymirae Co.)

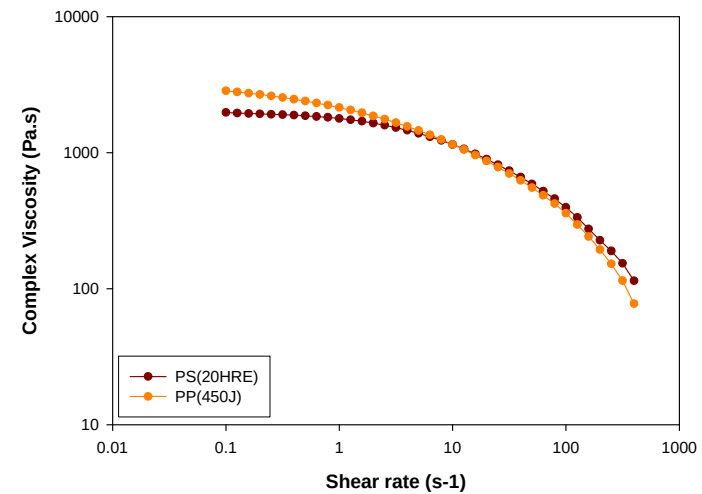
● Density : 0.95 g/cm<sup>3</sup>

● MFI: 3.24 g/10min

● Polystyrene (20HR(E), LG CHEM)

● Density : 1.05 g/cm<sup>3</sup>

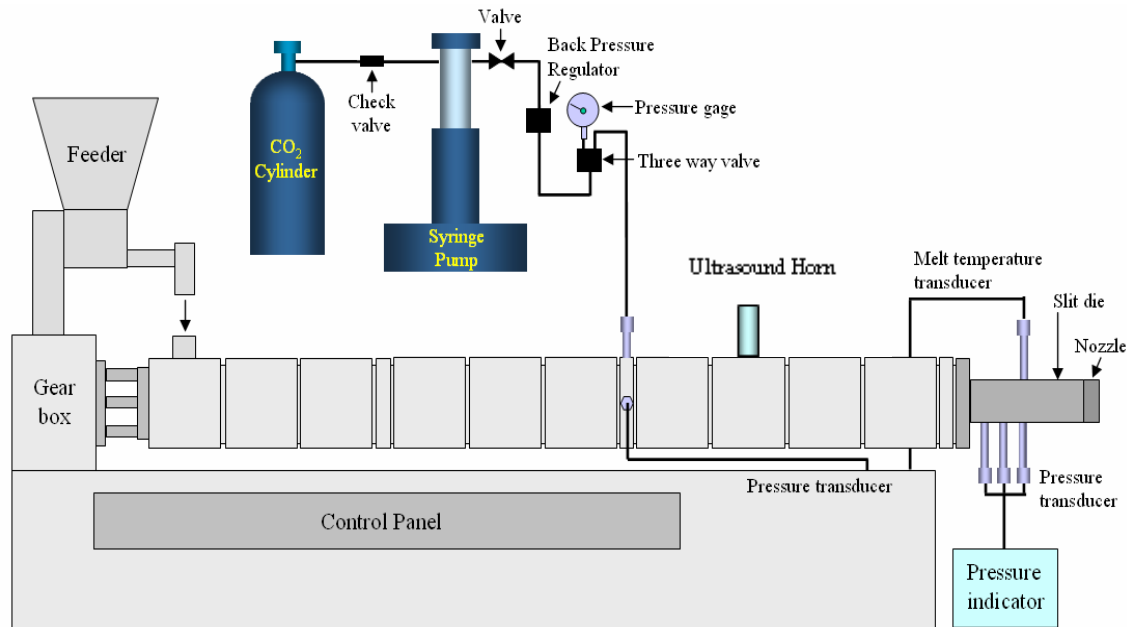
● MFI: 6 g/10min



### Carbon dioxide

● degree of purity: 99.99 %

## ● Manufacturing Process of using scCO<sub>2</sub> & Ultrasound

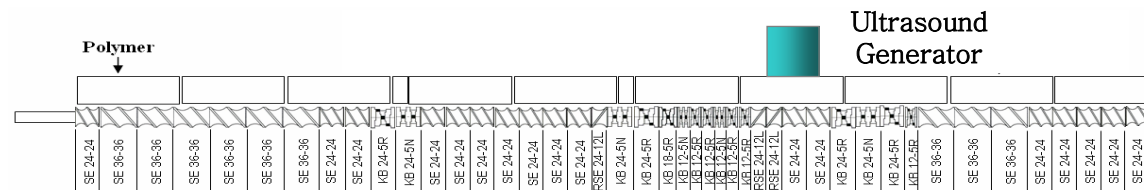


● Screw diameter: 25 mm

● L/D: 41

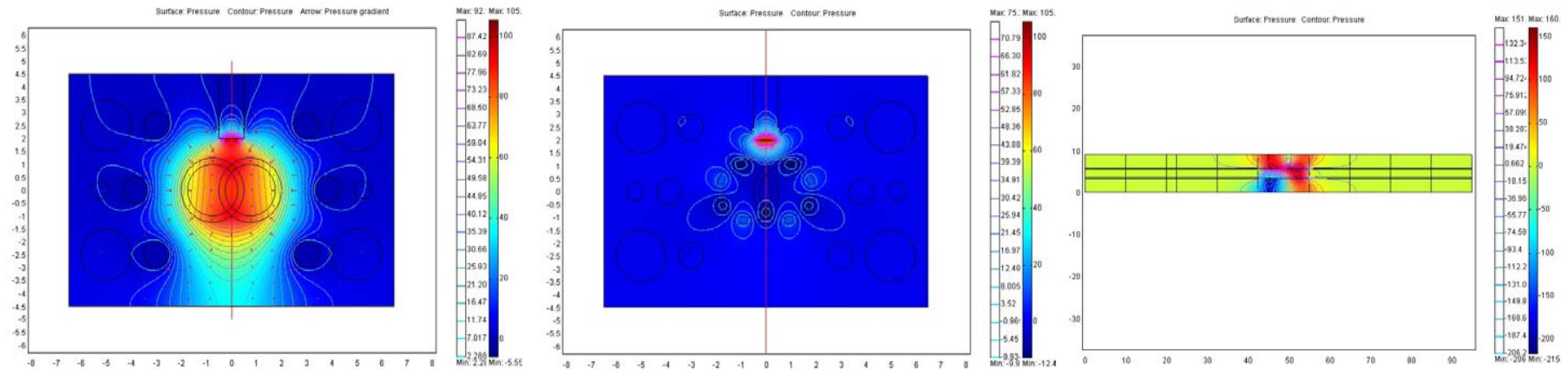
● Segmented type screw

Ultrasonic Device : MPI-MASTERSONIC® (MSG-IX)—[www.mpi-ultrasonics.com](http://www.mpi-ultrasonics.com) & [www.mastersonics.com](http://www.mastersonics.com)

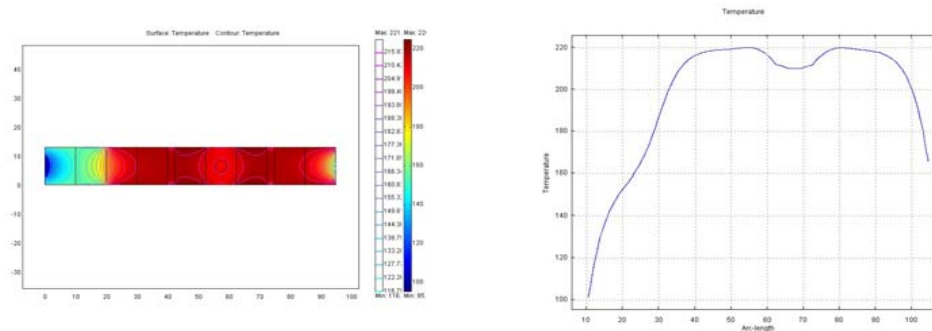


## ● Acoustic & Temperature Simulation of Extruder Barrel

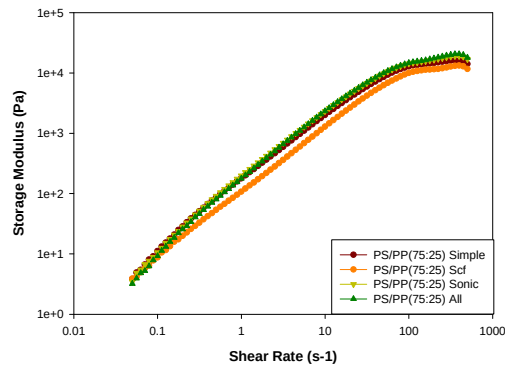
### ● Acoustic Simulation



### ● Barrel Temperature Simulation



## Method of Interfacial Tension Calculation



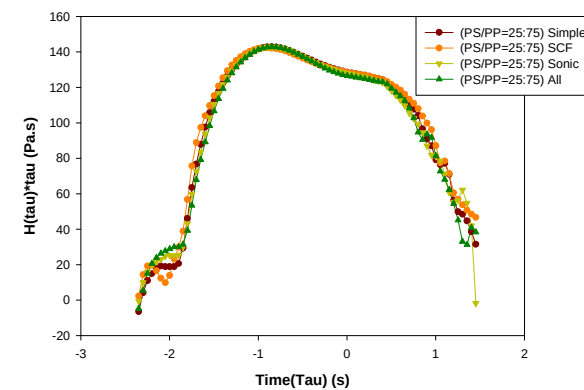
### Ferry and Tschoegl model

$$H(\tau) = G \left[ \frac{d \log G}{d \log \omega} - \frac{1}{2} \left( \frac{d \log G}{d \log \omega} \right)^2 - \frac{1}{4.606 d} \frac{d^2 \log G}{(\log \omega)^2} \right] \frac{1}{\omega} = \frac{\tau}{\sqrt{2}}$$

### Choi and Schowalter model

$$\tau_0 = \frac{\eta_m R}{\alpha} \frac{(19k + 16)(2k + 3)}{40(k + 1)}$$

$$\tau_1 = \tau_0 \left[ 1 + \Phi \frac{5(19k + 16)}{4(k + 1)(2k + 3)} \right]$$





## ● Method of Viscosity Calculation

### ● Working equations for slit rheometer

#### ● Viscosity

$$\eta = \tau_w / \dot{\gamma}_w$$

#### ● Wall shear stress

$$\tau_w = \frac{H}{2(1 + H/W)} \frac{dP}{dx}$$

#### ● Apparent shear rate

$$\dot{\gamma}_{ap} = 6Q / WH^2$$

#### ● Wall shear rate

$$\dot{\gamma}_w = \frac{\dot{\gamma}_{app}}{3} \left( 2 + \frac{d \ln \dot{\gamma}_{app}}{d \ln \tau_w} \right)$$

#### ● Volumetric flow rate

$$Q = \dot{m} / \rho$$

$P$ : pressure

$x$ : length

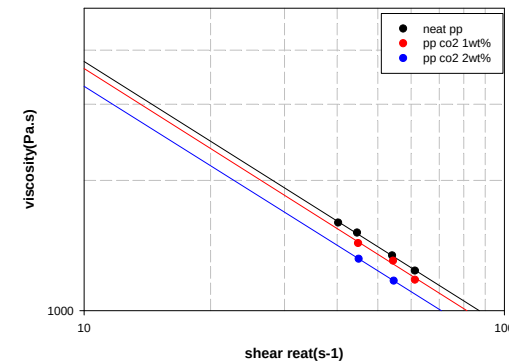
$H$ : height

$W$ : width

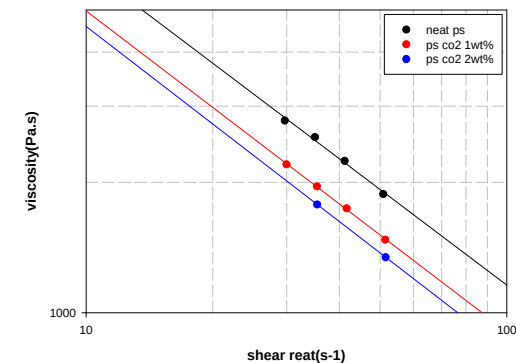
$\dot{m}$

$\rho$

PP CO2 mixture



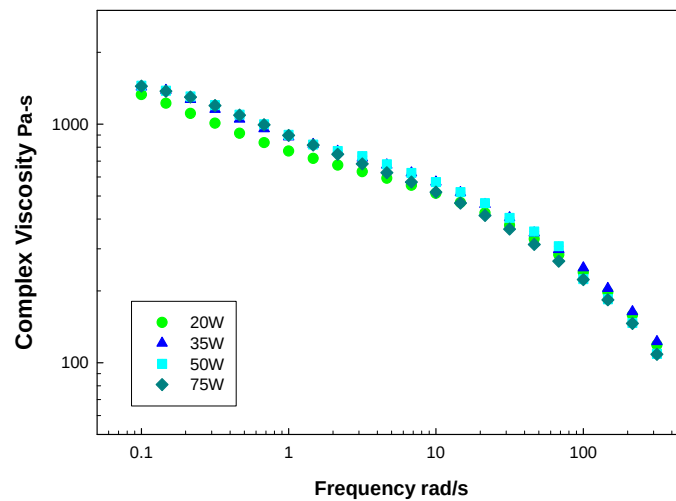
PS CO2 mixture



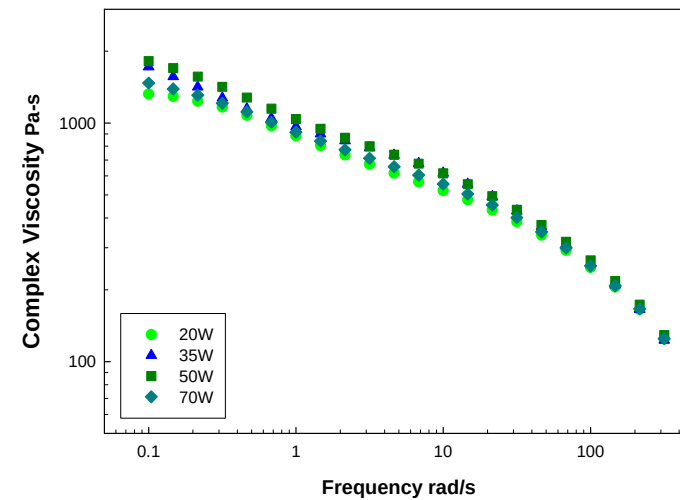


## ● Effect of Sonication Power on Polymer Blend

Sonicated Mixing

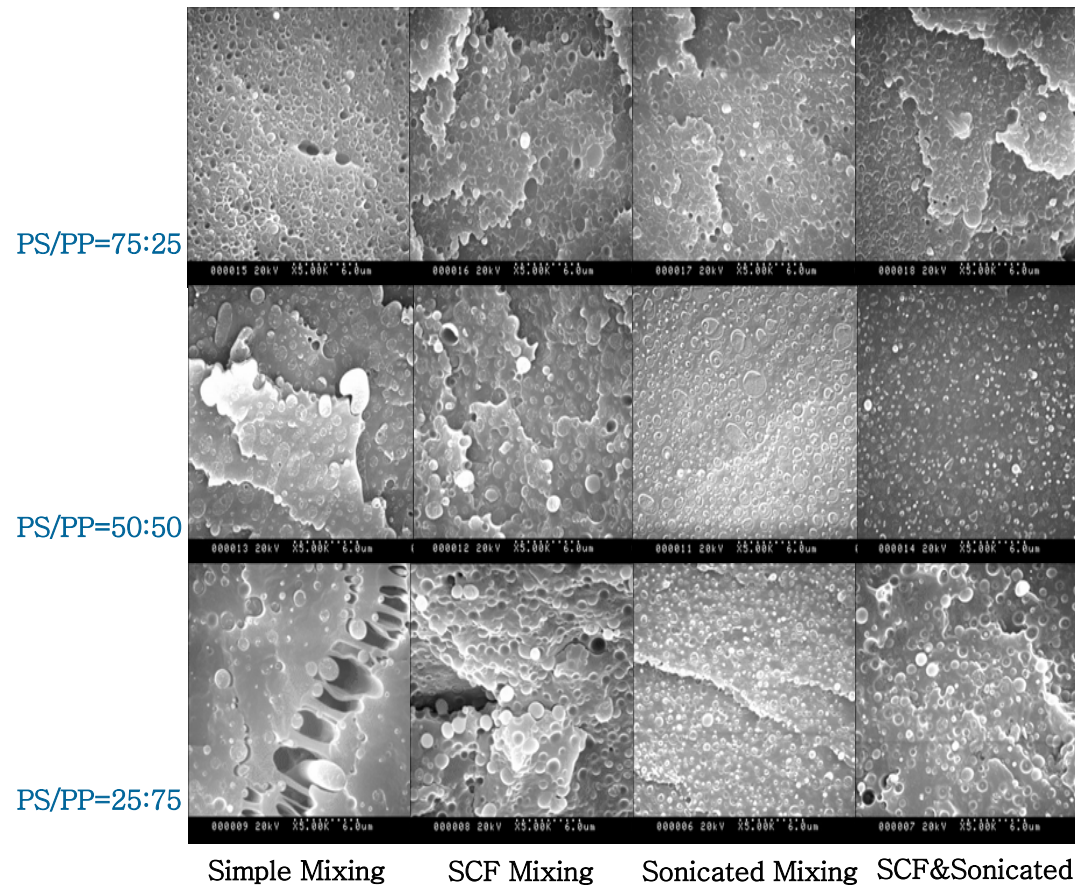


SCF & Sonicated Mixing

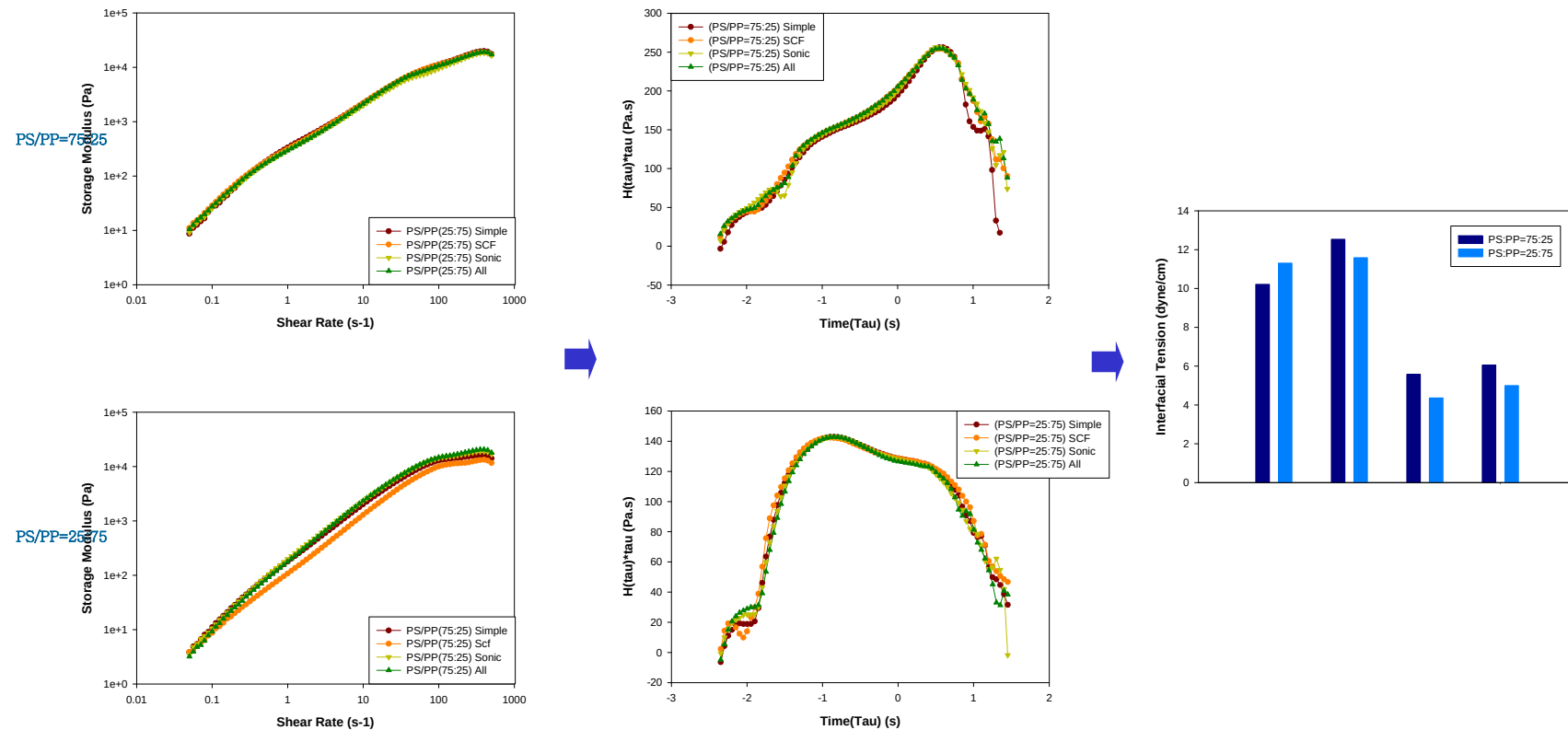


# Results and discussion

## ● SEM images of PP/PS Blends:([www.mpi-ultrasonics.com](http://www.mpi-ultrasonics.com) & [www.mastersonics.com](http://www.mastersonics.com))

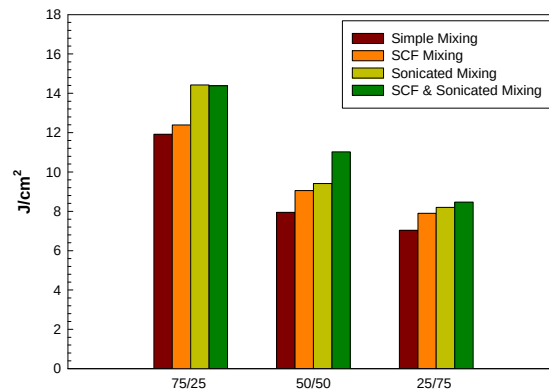


## ● Interfacial Tension Estimation

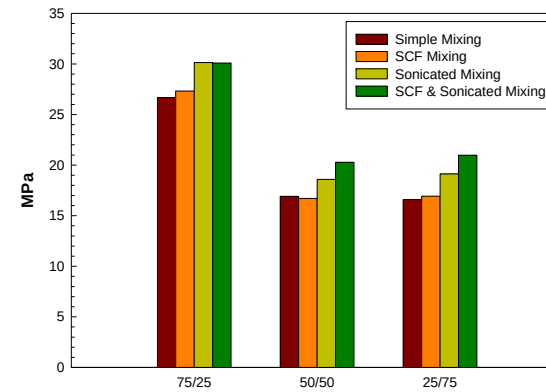


## ● Mechanical properties

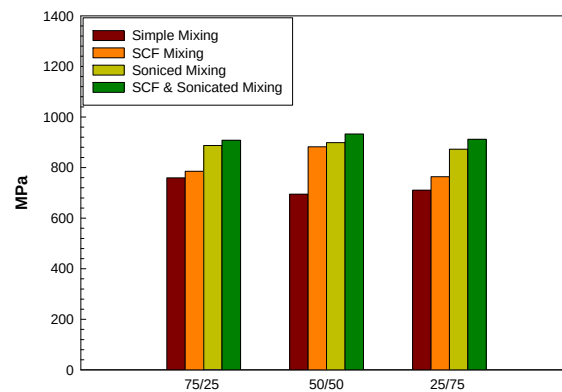
Impact Strangth



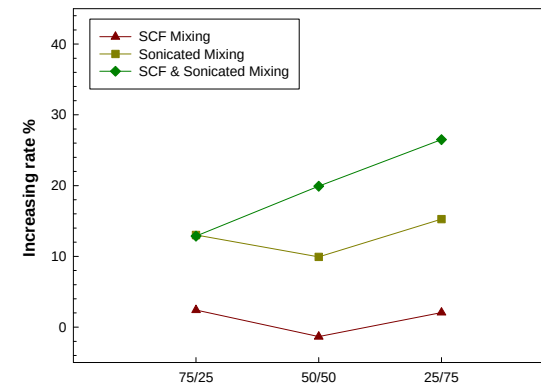
Tensile Strangth



Young's Modulus

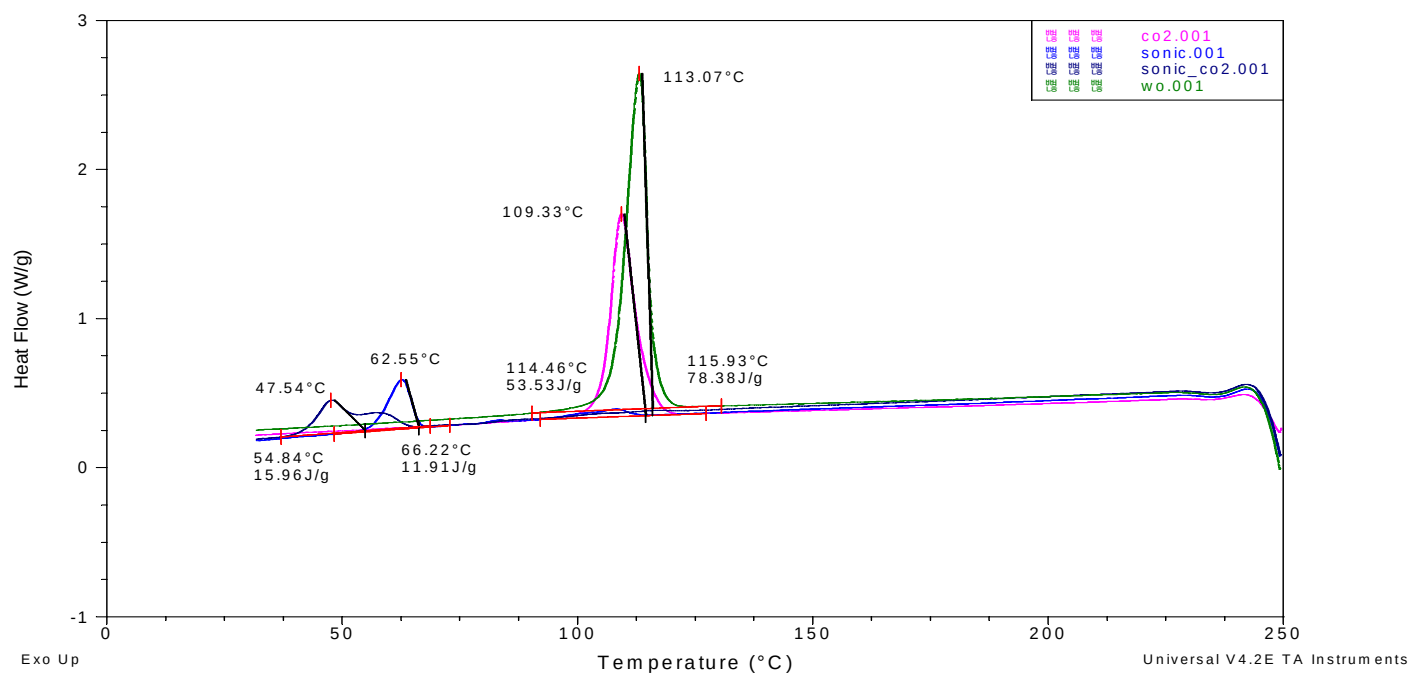


Tensile Strength

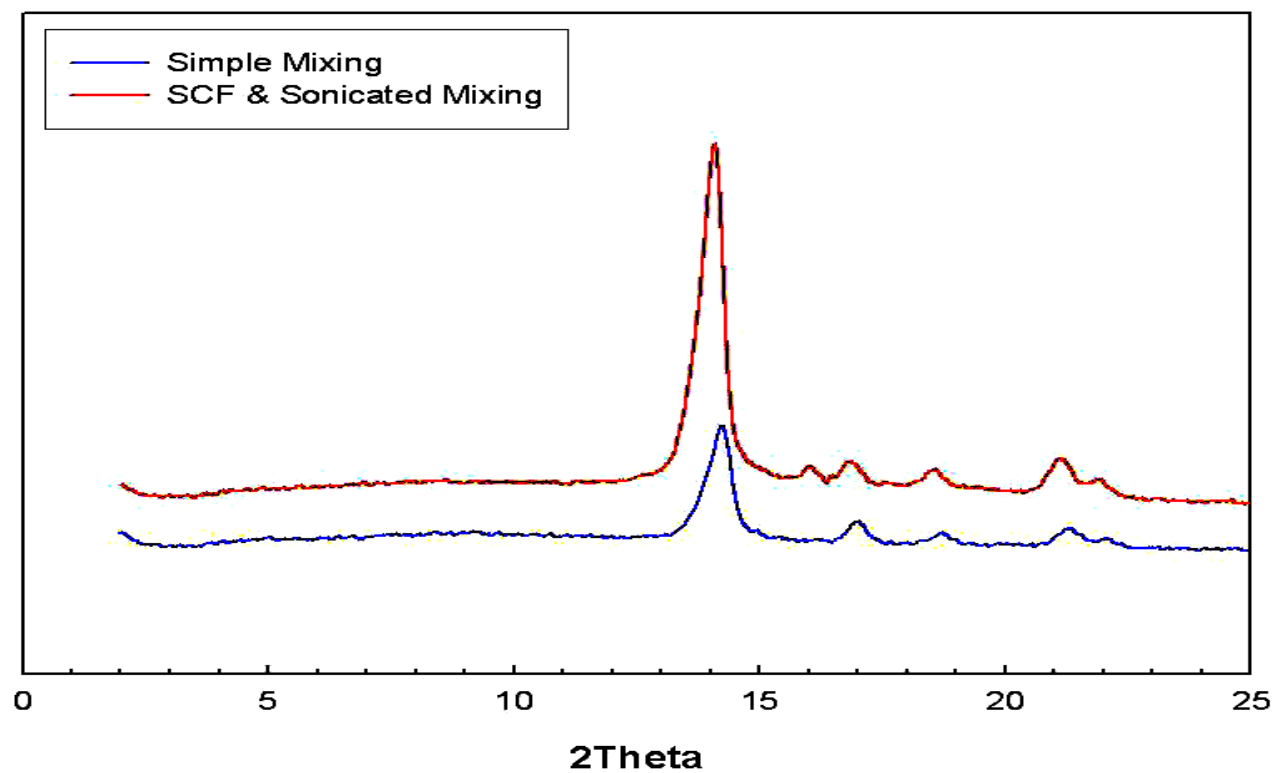


# Results and discussion

## ● Tc curve of PP/PS Blend using DSC



## ● WAXD patterns of PP/PS =75/25 blend



# Conclusions

- By using high intensity ultrasound ([www.mpi-ultrasonics.com](http://www.mpi-ultrasonics.com)), it was possible to change rheological properties of various thermoplastics during melt mixing.
- Compatibility was increased in immiscible polymer blends without any compatibilizers: mutual coupling between different radical PP and PS
- Supercritical CO<sub>2</sub> exhibited synergistic effects with ultrasound on the morphology and properties of the polymer blends.