

The effect of adding natural rubber on the thermophysical characteristics of polylactide

Sergei M. Lomakin, Natalia G. Shilkina, Svetlana Z. Rogovina, Olga P. Kuznetsova, Miraga M. Gasymov, Regina S. Smykovskaya, Natalia A. Erina and Aleksandr A. Berlin

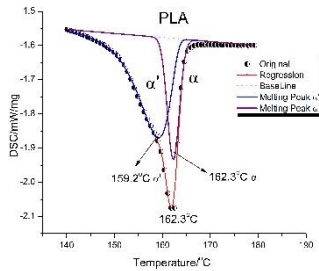
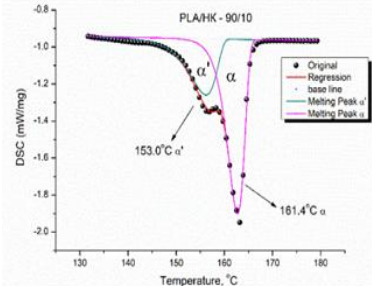
PLA–NR composites were obtained under the shear deformation in a closed-type mixer ‘Plastograph EC’ (Brabender, Germany) at $T = 170\text{ }^{\circ}\text{C}$ and a rotor speed of 100 rpm for 10 min.

Thermophysical characteristics of PLA–NR composites were studied using DSC method on a DSC–204 F1 (NETZSCH-Gerätebau GmbH, Germany) calorimeter at the heating rate of 10 K min^{-1} in an inert atmosphere. To maintain the original structure of PLA–NR composites, an one-stage heating protocol was employed in DSC studies. The degree of crystallinity of PLA samples, χ (%), was calculated by equation

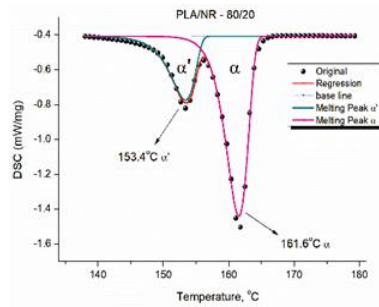
$$\chi = \frac{\Delta H_m - \Delta H_{cc}}{\Delta H_m^{100} (1 - w_{NR})} \times 100\%,$$

where ΔH_m is the enthalpy of melting, ΔH_{cc} is the enthalpy of ‘cold’ crystallization, w_{NR} is the mass fraction of NR, ΔH_m^{100} is the theoretical value (93.1 J g^{-1}) of the melting enthalpy of 100%-crystalline poly(L-lactide). According to the technical specifications of DSC 204 F1 Phoenix, the permissible relative errors in the enthalpy (thermal effects) are $\pm 3\%$.

Table S1 Deconvolution of PLA melting peaks: graphical comparison of model curves and experimental data

Compositions (wt%)	Deconvolution of PLA melting peaks: graphical comparison of model curves and experimental data	Calculated values of partial melting heats of α and α' crystalline PLA phases in PLA–NR composites	Statistics
PLA (D1)		$S(\alpha') = 2.6761\text{ (70.0\%)}$ $\Delta H_m(\alpha') = -14.14\text{ J g}^{-1}$ $S(\alpha) = 1.1064\text{ (30.0\%)}$ $\Delta H_m(\alpha) = -6.06\text{ J g}^{-1}$	Correlation coefficient: 0.9981 Rel. precision: 0.001000 t -critical (0.95; 49): 2.005 Durbin–Watson Value: 1.195
PLA–NR = 90 : 10 (D2)		$S(\alpha') = 2.3663\text{ (34.4\%)}$ $\Delta H_m(\alpha') = -12.80\text{ J g}^{-1}$ $S(\alpha) = 4.5057\text{ (65.6\%)}$ $\Delta H_m(\alpha) = -24.40\text{ J g}^{-1}$	Correlation coefficient: 0.9975 Rel. precision: 0.001000 t -critical (0.95; 62): 1.993 Durbin–Watson Value: 1.344

PLA-NR = 80 : 20
(D3)



$$S(\alpha') = 1.8600 \text{ (25\%)}$$

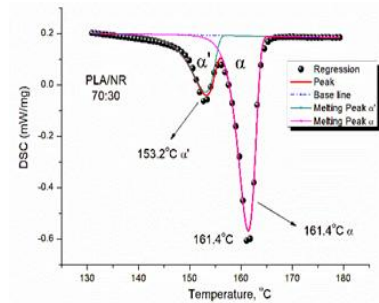
$$\Delta H_m(\alpha') = -9.3 \text{ J g}^{-1}$$

$$S(\alpha) = 4.5650 \text{ (75\%)}$$

$$\Delta H_m(\alpha) = -27.9 \text{ J g}^{-1}$$

Correlation coefficient: 0.9972
Rel. precision: 0.001000
 t -critical (0.95; 52): 2.001
Durbin-Watson Value: 1.149

PLA-NR = 70 : 30
(D4)



$$S(\alpha') = 1.3730 \text{ (29\%)}$$

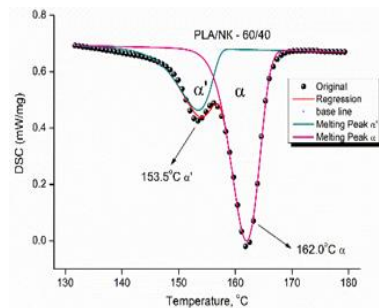
$$\Delta H_m(\alpha') = -10.27 \text{ J g}^{-1}$$

$$S(\alpha) = 3.3557 \text{ (71\%)}$$

$$\Delta H_m(\alpha) = -25.12 \text{ J g}^{-1}$$

Correlation coefficient: 0.9957
Rel. precision: 0.001000
 t -critical (0.95; 62): 1.993
Durbin-Watson Value: 0.948

PLA-NR = 60 : 40
(D5)



$$S(\alpha') = 1.7082 \text{ (28.7\%)}$$

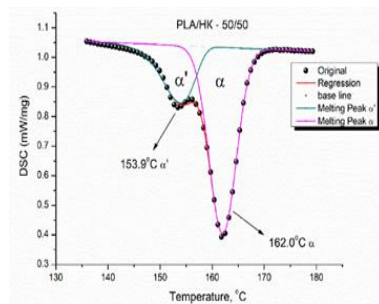
$$\Delta H_m(\alpha') = -9.67 \text{ J g}^{-1}$$

$$S(\alpha) = 4.2497 \text{ (71.3\%)}$$

$$\Delta H_m(\alpha) = -24.03 \text{ J g}^{-1}$$

Correlation coefficient: 0.9981
Rel. precision: 0.001000
 t -critical (0.95; 61): 1.993
Durbin-Watson Value: 0.467

PLA-NR = 50 : 50
(D6)



$$S(\alpha') = 1.5566 \text{ (27.5\%)}$$

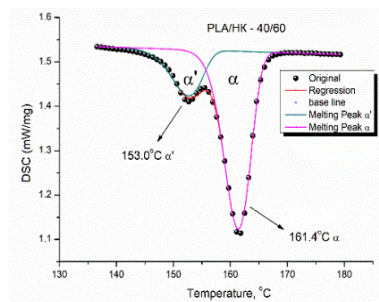
$$\Delta H_m(\alpha') = -8.91 \text{ J g}^{-1}$$

$$S(\alpha) = 4.1047 \text{ (72.5\%)}$$

$$\Delta H_m(\alpha) = -23.49 \text{ J g}^{-1}$$

Correlation coefficient: 0.9991
Rel. precision: 0.001000
 t -critical (0.95; 55): 1.998
Durbin-Watson Value: 0.409

PLA-NR = 40 : 60
(D7)



$$S(\alpha') = 0.7165 \text{ (23.3\%)}$$

$$\Delta H_m(\alpha') = -7.41 \text{ J g}^{-1}$$

$$S(\alpha) = 2.3590 \text{ (76.7\%)}$$

$$\Delta H_m(\alpha) = -24.39 \text{ J g}^{-1}$$

Correlation coefficient: 0.9989
Rel. precision: 0.001000
 t -critical (0.95; 54): 1.999
Durbin-Watson Value: 0.556

Reference

S1 L.-T. Lim, R. Auras and M. Rubino, *Prog. Polym. Sci.*, 2008, **33**, 820;
<https://doi.org/10.1016/j.progpolymsci.2008.05.004>.