# SUPPORTING INFORMATION

## Examples of stress/strain curves

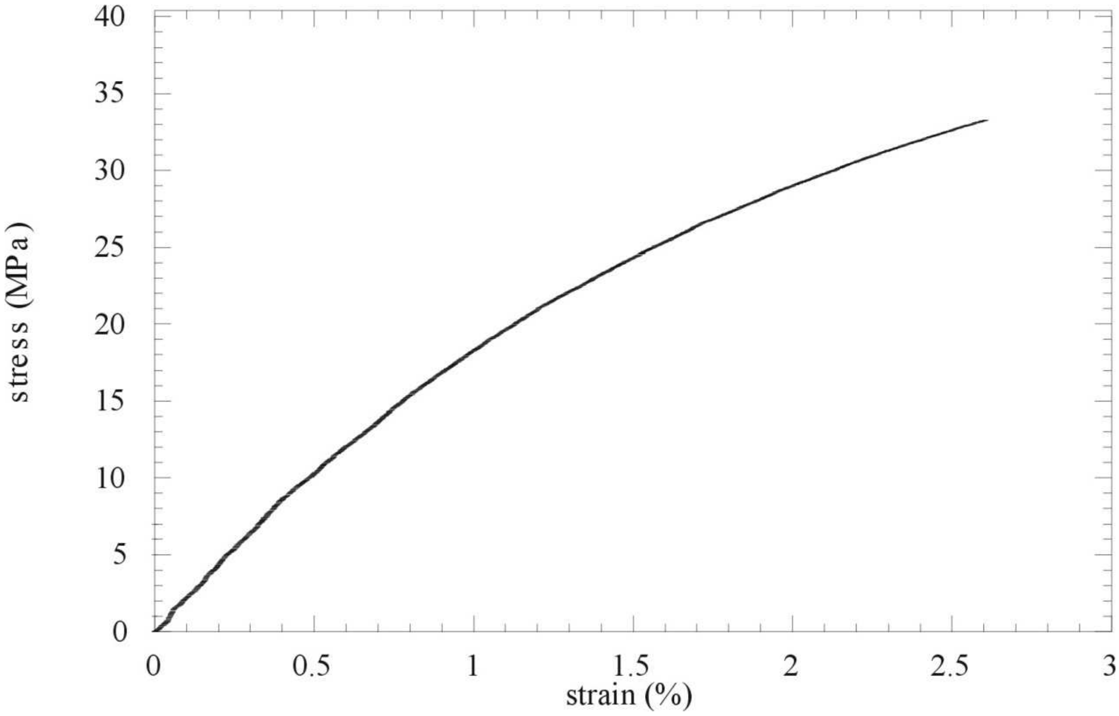


Fig. 1s Pectin HM

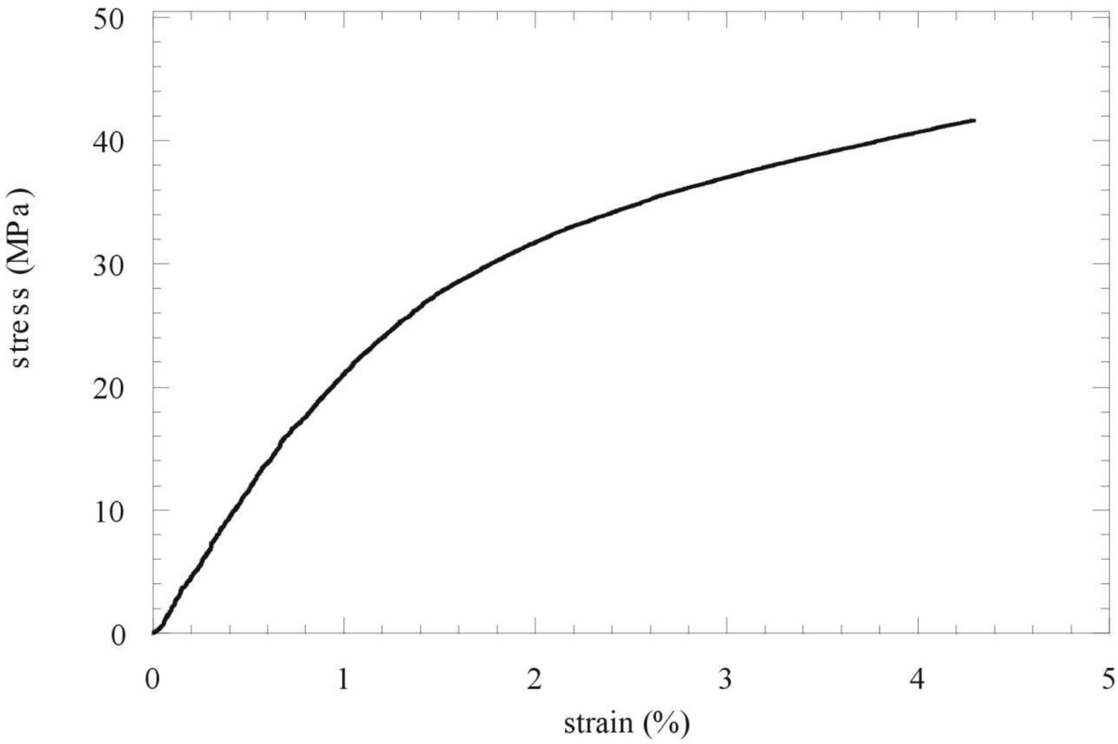


Fig. 2s Pectin LM

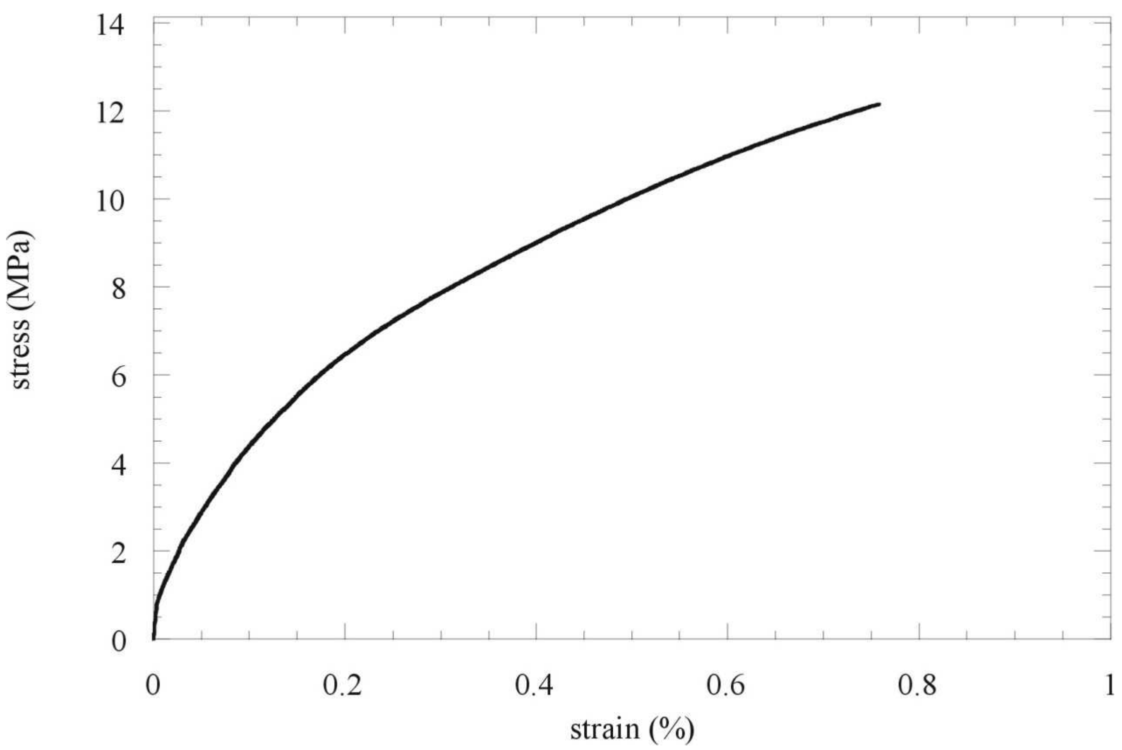

Fig. 3s Pectin HM/HNTs ($C_f$ = 80%)

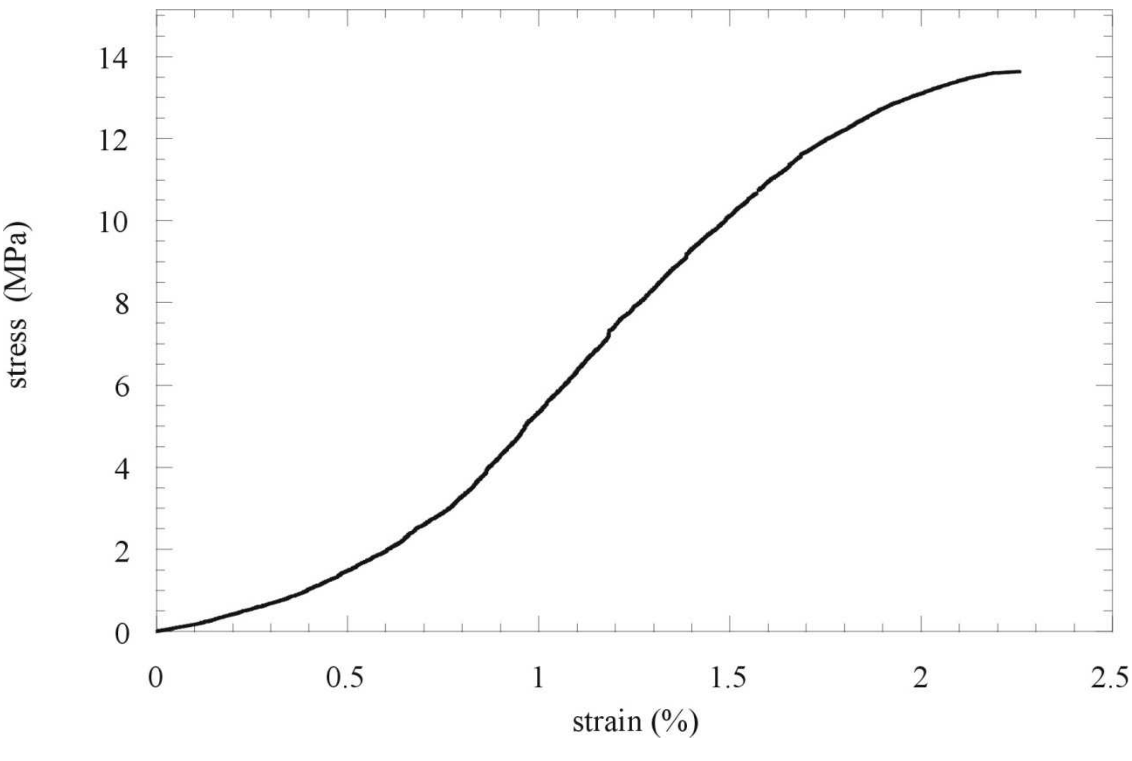


Fig. 4s Pectin HM/Laponite RD ($C_f$ = 20%)

**The dynamic mechanical tests under oscillatory**

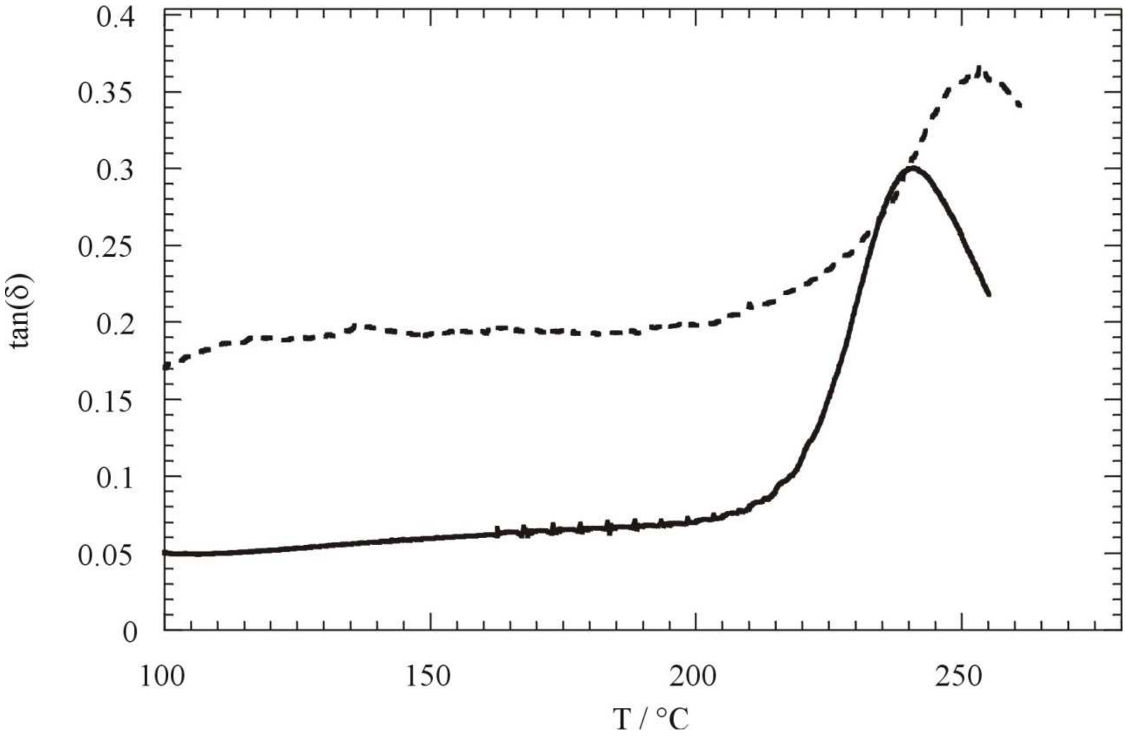


Fig. 5s. The loss tangent as a function of temperature for HM pectin/HNTs. —— $C_f = 20\%$, – – $C_f = 60\ \%$.

## TG curves

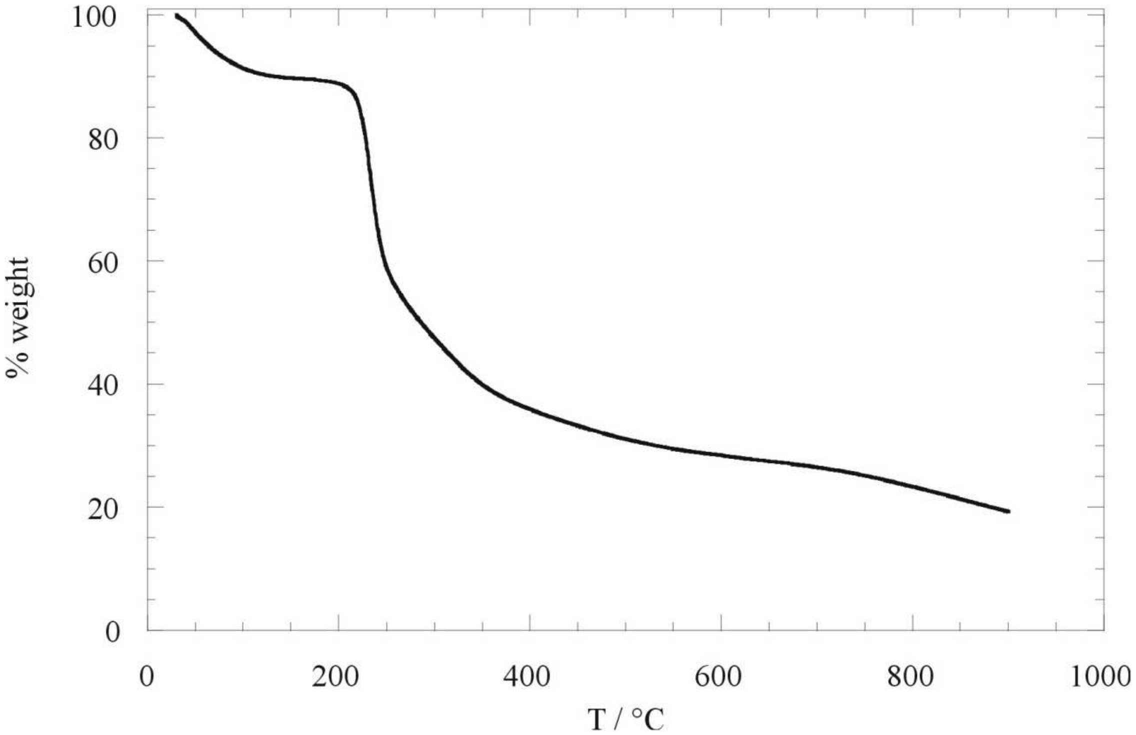


Fig 6s. TG curve of HM Pectin

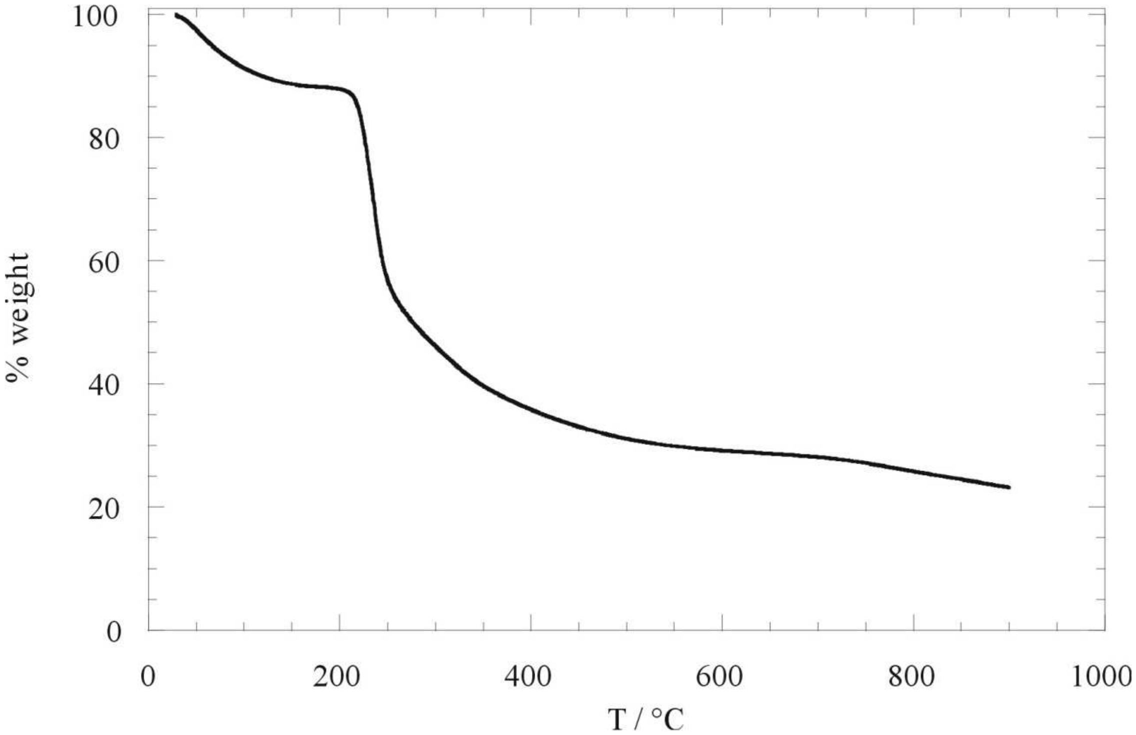


Fig. 7s TG curve of LM Pectin

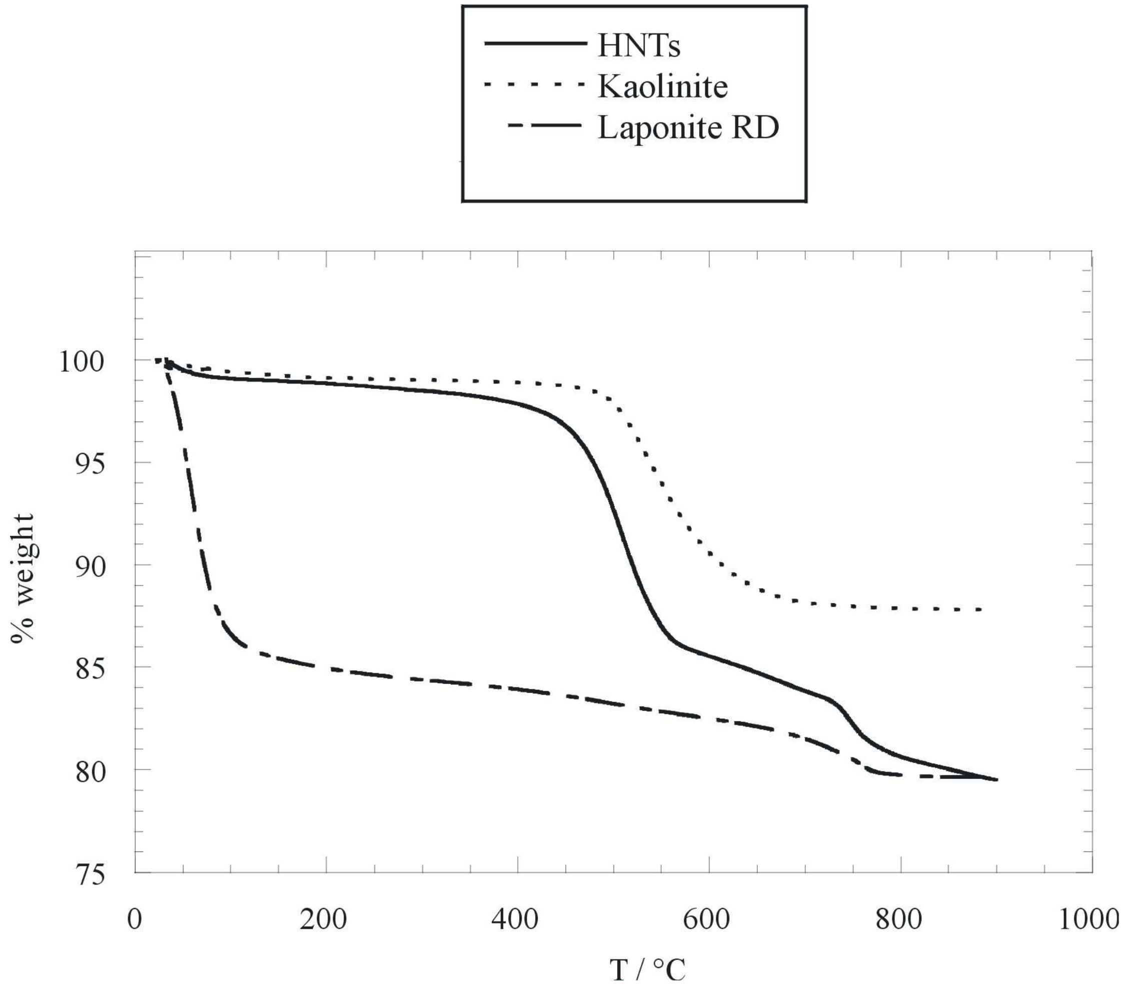

Fig. 8s TG curves of the used nanofillers

## DSC curves

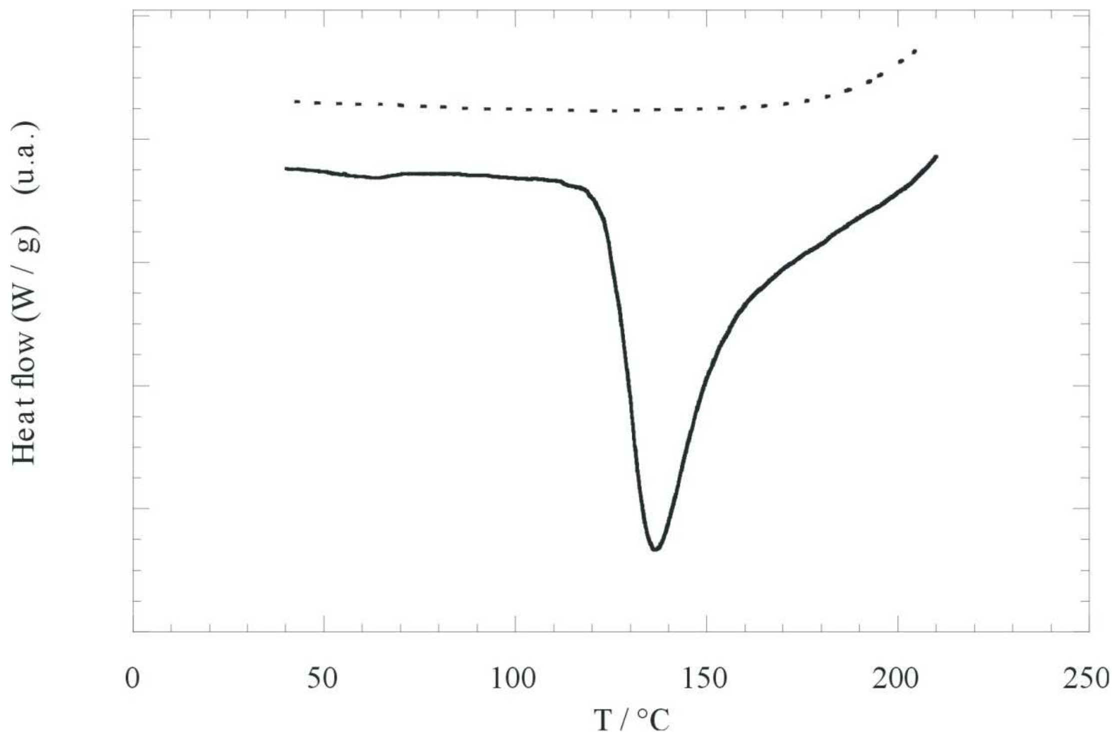


Figure 9s. Thermogram of HM Pectin. Full line is during heating and dotted line is upon cooling.

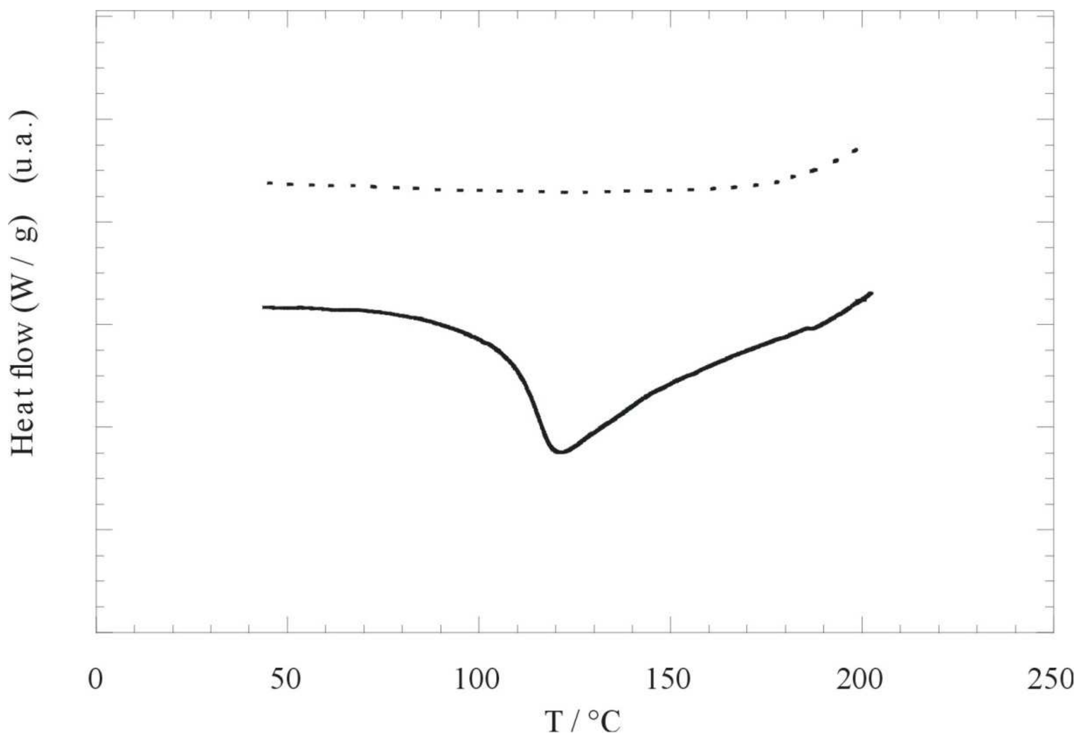


Figure 10s. Thermogram of LM Pectin. Full line is during heating and dotted line is upon cooling.

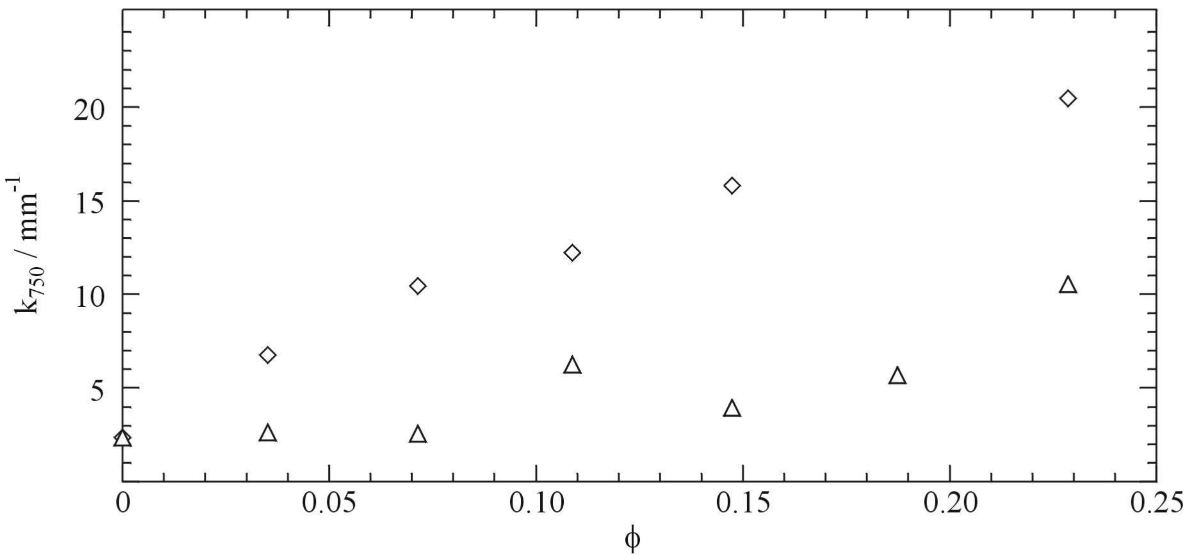

Figure 11s. Dependence of the attenuation coefficient at 750 nm on the filler volume fraction for LM Pectin mixed with HNTs (◊) and laponite RD (Δ).

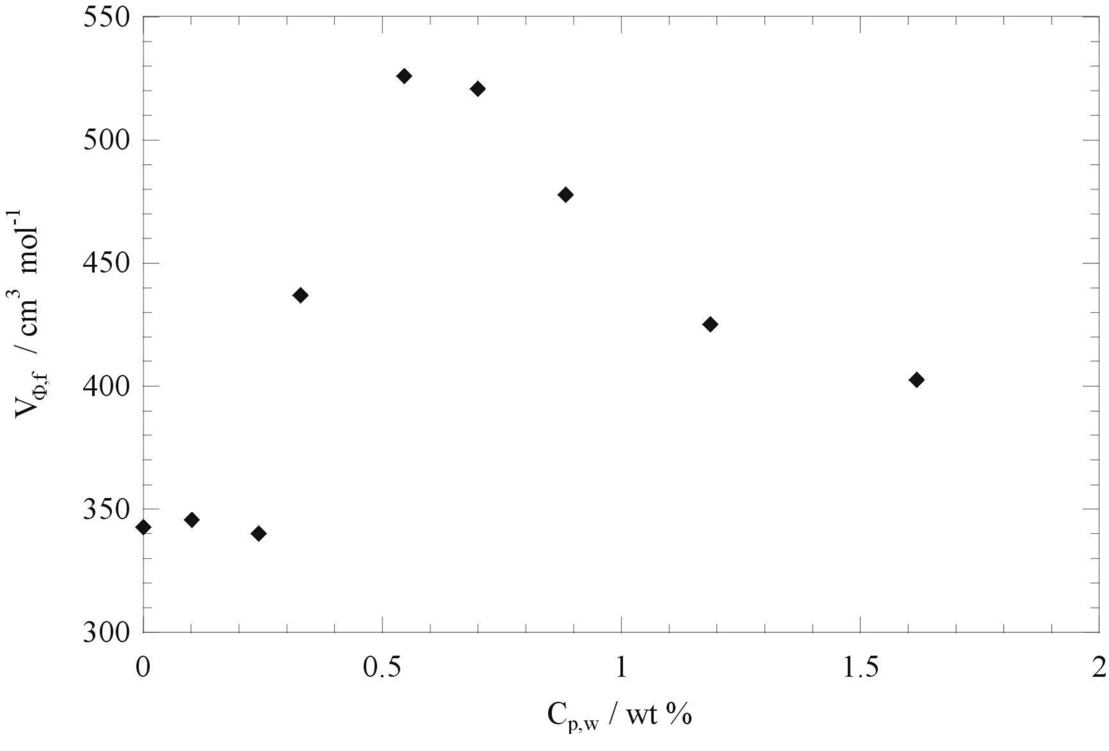


Figure 12s. Apparent molar volume of laponite RD as a function of LM pectin concentration at 35 °C. The error is within the symbols being ± 0.4 cm$^3$ mol$^{-1}$.

**Table 1s**. Apparent molar volume of laponite RD in aqueous LM Pectin solutions at 25°C

| $C_{p,w}$ | d | $d_0$ | $m_f$ | $V_{\Phi,f}$ |
|---|---|---|---|---|
| 0 | 0.999642 | 0.997047 | 6.256 | 345.8 ± 0.3 |
| 0.152 | 1.000517 | 0.997683 | 6.814 | 344.7 ± 0.3 |
| 0.250 | 1.000883 | 0.998092 | 6.647 | 340.7 ± 0.3 |
| 0.401 | 1.000510 | 0.998726 | 6.090 | 468.1 ± 0.3 |
| 0.495 | 1.000645 | 0.999119 | 6.051 | 508.9 ± 0.3 |
| 0.699 | 1.001587 | 0.999975 | 6.503 | 513.0 ± 0.3 |
| 0.845 | 1.002197 | 1.000576 | 5.812 | 481.9 ± 0.3 |
| 1.089 | 1.003486 | 1.001610 | 5.967 | 446.2 ± 0.3 |
| 1.502 | 1.005560 | 1.003365 | 6.045 | 397.6 ± 0.3 |

Units are: $C_{p,w}$, wt%; d and $d_0$, g $cm^{-3}$; $m_f$, mmol $kg^{-1}$; $V_{\Phi,f}$, $cm^3$ $mol^{-1}$.

**Table 2s**. Apparent molar volume of laponite RD in aqueous HM Pectin solutions at 25°C

| $C_{p,w}$ | d | $d_0$ | $m_f$ | $V_{\Phi,f}$ |
|---|---|---|---|---|
| 0 | 0.999642 | 0.997047 | 6.256 | 345.8 ± 0.3 |
| 0.105 | 1.000067 | 0.997507 | 6.144 | 344.0 ± 0.3 |
| 0.266 | 1.000686 | 0.998164 | 5.940 | 336.1 ± 0.3 |
| 0.427 | 1.000409 | 0.998841 | 5.964 | 498.3 ± 0.3 |
| 0.532 | 1.000701 | 0.999285 | 6.197 | 532.7 ± 0.3 |
| 0.845 | 1.002020 | 1.000580 | 6.025 | 521.8 ± 0.3 |
| 1.152 | 1.003834 | 1.001873 | 6.395 | 453.9 ± 0.3 |
| 1.389 | 1.004912 | 1.002874 | 6.013 | 421.7 ± 0.3 |
| 1.588 | 1.005953 | 1.003746 | 6.273 | 408.7 ± 0.3 |

Units are: $C_{p,w}$, wt%; d and $d_0$, g $cm^{-3}$; $m_f$, mmol $kg^{-1}$; $V_{\Phi,f}$, $cm^3$ $mol^{-1}$.

**Table 3s**. Apparent molar volume of laponite RD in aqueous LM Pectin solutions at 35°C

| $C_{p,w}$ | d | $d_0$ | $m_f$ | $V_{\Phi,f}$ |
|---|---|---|---|---|
| 0 | 0.996905 | 0.994024 | 6.902 | 342.9 ± 0.3 |
| 0.102 | 0.997113 | 0.994445 | 6.435 | 345.8 ± 0.3 |
| 0.242 | 0.997653 | 0.995000 | 6.314 | 340.2 ± 0.3 |
| 0.330 | 0.997213 | 0.995359 | 5.716 | 437.0 ± 0.3 |
| 0.546 | 0.997684 | 0.996225 | 6.182 | 526.0 ± 0.3 |
| 0.701 | 0.998294 | 0.996861 | 5.945 | 520.8 ± 0.3 |
| 0.883 | 0.999383 | 0.997588 | 6.330 | 477.7 ± 0.3 |
| 1.186 | 1.000890 | 0.998801 | 6.219 | 425.0 ± 0.3 |
| 1.618 | 1.002724 | 1.000550 | 6.067 | 402.5 ± 0.3 |

Units are: $C_{p,w}$, wt%; d and $d_0$, g $cm^{-3}$; $m_f$, mmol $kg^{-1}$; $V_{\Phi,f}$, $cm^3$ $mol^{-1}$.

**Table 4s**. Apparent molar volume of Halloysite in aqueous LM Pectin solutions at 25°C

| $C_{p,w}$ | d | $d_0$ | $m_f$ | $V_{\Phi,f}$ |
|---|---|---|---|---|
| 0.071 | 0.998235 | 0.997359 | 5.886 | 145.2 ± 0.3 |
| 0.152 | 0.998761 | 0.997683 | 5.473 | 96.9 ± 0.4 |
| 0.348 | 1.000146 | 0.998505 | 5.864 | 13.8 ± 0.3 |
| 0.452 | 1.000618 | 0.998945 | 5.391 | -16.4 ± 0.4 |
| 0.590 | 1.001345 | 0.999513 | 5.528 | -37.3 ± 0.4 |
| 0.720 | 1.001879 | 1.000068 | 5.474 | -36.6 ± 0.4 |
| 0.967 | 1.002765 | 1.001092 | 5.493 | -10.0 ± 0.4 |
| 1.034 | 1.003210 | 1.001360 | 6.065 | -10.4 ± 0.3 |
| 1.298 | 1.004066 | 1.002500 | 5.855 | 27.7 ± 0.3 |
| 1.590 | 1.005298 | 1.003750 | 5.891 | 32.2 ± 0.3 |

Units are: $C_{p,w}$, wt%; d and $d_0$, g $cm^{-3}$; $m_f$, mmol $kg^{-1}$; $V_{\Phi,f}$, $cm^3$ $mol^{-1}$.

**Table 5s**. Apparent molar volume of Halloysite in aqueous LM Pectin solutions at 35°C

| $C_{p,w}$ | d | $d_0$ | $m_f$ | $V_{\Phi,f}$ ($cm^3$ $mol^{-1}$) |
|---|---|---|---|---|
| 0.073 | 0.995432 | 0.994325 | 5.603 | 95.9 ± 0.4 |
| 0.153 | 0.996025 | 0.994647 | 5.886 | 59.0 ± 0.3 |
| 0.237 | 0.996497 | 0.994978 | 6.303 | 52.1 ± 0.3 |
| 0.550 | 0.998214 | 0.996233 | 6.380 | -17.5 ± 0.3 |
| 0.691 | 0.998656 | 0.996833 | 5.817 | -20.2 ± 0.3 |
| 0.900 | 0.999535 | 0.997641 | 6.185 | -12.7 ± 0.3 |
| 1.130 | 1.000398 | 0.998596 | 6.144 | 0.4 ± 0.3 |
| 1.362 | 1.001257 | 0.999550 | 5.990 | 9.1 ± 0.3 |
| 1.693 | 1.002594 | 1.000886 | 6.236 | 20.5 ± 0.3 |

Units are: $C_{p,w}$, wt%; d and $d_0$, g $cm^{-3}$; $m_f$, mmol $kg^{-1}$; $V_{\Phi,f}$, $cm^3$ $mol^{-1}$.

**Table 6s.** Specific volume for LM Pectin 0.5% in aqueous KCl solution at 25 °C.

| $m_{KCl}$ | D | $d_0$[a] | $v_{sp,M}$ |
|---|---|---|---|
| 0.0490 | 1.001622 | 0.999359 | 0.5765 ± 0.004 |
| 0.1613 | 1.006851 | 1.004576 | 0.5734 ± 0.004 |
| 0.3199 | 1.014092 | 1.011809 | 0.5710 ± 0.004 |
| 0.5002 | 1.022237 | 1.019886 | 0.5574 ± 0.004 |

Units are: $m_{KCl}$, mol kg$^{-1}$; d and $d_0$, g cm$^{-3}$; $v_{sp,M}$, cm$^3$ g$^{-1}$.
[a]calculated from "Vaslow, F. The Apparent Molal Volumes of the Alkali Metal Chlorides in Aqueous Solution and Evidence for Salt-Induced Structure Transitions." *J. Phys. Chem.,* **1966**,*70,* 2286-2294.

**Table 7s**. Apparent molar volume of Laponite RD in water + LM Pectin 0.5% + KCl mixtures at 25°C.

| $m_{KCl}$ | d | $d_0$ | $m_f$ | $V_{\Phi,f}$ |
|---|---|---|---|---|
| 0.0490 | 1.002765 | 1.001622 | 6.380 | 581.2 ± 0.3 |
| 0.1613 | 1.007811 | 1.006851 | 5.970 | 597.3 ± 0.3 |
| 0.3199 | 1.015739 | 1.014092 | 6.324 | 497.0 ± 0.3 |
| 0.5002 | 1.024457 | 1.022237 | 6.401 | 412.3 ± 0.3 |

Units are: $m_{KCl}$, mol kg$^{-1}$; d and $d_0$, g cm$^{-3}$; $m_f$, mmol kg$^{-}$1; $V_{\Phi,f}$, cm$^3$ mol$^{-1}$

**Table 8s.** Apparent molar volume of Laponite RD in water + KCl mixtures at 25°C.

| $m_{KCl}$ | d | $d_0$ | $m_f$ | $V_{\Phi,f}$ |
|---|---|---|---|---|
| 0.1429 | 1.004425 | 1.003805 | 6.028 | 656.3 ± 0.3 |
| 0.3018 | 1.011605 | 1.010973 | 6.757 | 661.5 ± 0.3 |
| 0.4991 | 1.020363 | 1.019691 | 6.244 | 643.0 ± 0.3 |

Units are: $m_{KCl}$, mol kg$^{-1}$; d and $d_0$, g cm$^{-3}$; $m_f$, mmol kg$^{-}$1; $V_{\Phi,f}$, cm$^3$ mol$^{-1}$

**Table 9s.** Experimental intercept and slope for the dependence of $ML_{120}$ on the filler concentration.[a]

| Bionanocomposites | intercept | slope |
|---|---|---|
| HM Pectin/HNT | 11.0 ± 0.2 | - 0.094 ± 0.004 |
| HM Pectin/kaolinite | 11.1 ± 0.7 | - 0.10 ± 0.01 |
| LM Pectin/HNT | 12.3 ± 0.4 | - 0.109 ± 0.008 |
| LM Pectin/kaolinite | 12.5 ± 0.5 | - 0.123 ± 0.009 |

[a]Unit for intercept is wt %.

**Table 10s**. Calculated and experimental intercept and slope of Eq 8.

| Bionanocomposites | intercept | slope |
|---|---|---|
| HM Pectin/HNTs | 68 ± 2; 70[a] | - 0.46 ± 0.03; - 0.51[b] |
| HM Pectin/kaolinite | 72 ± 2; 70[a] | - 0.56 ± 0.03; - 0.59[b] |
| HM Pectin/laponite RD | 66 ± 1; 70[a] | - 0.58 ± 0.03, - 0.63[b] |
| LM Pectin/HNTs | 70 ± 3; 65[a] | - 0.49 ± 0.05; - 0.46[b] |
| LM Pectin/laponite RD | 65 ± 2; 65[a] | - 0.57 ± 0.06; - 0.58[b] |
| LM Pectin/kaolinite | 66 ± 3; 65[a] | - 0.56 ± 0.04; - 0.54 [b] |

[a]Computed intercept value of Eq 8; [b]computed slope value of Eq 8.