

# Supplementary Material: Effects of Fumed Silica and Draw Ratio on Nanocomposite Polypropylene Fibers

Luca Fambri, Izabela Dabrowska, Riccardo Ceccato and Alessandro Pegoretti

## 1. Statistical Analysis of Series I (Minitab 17 Software, Release 3.1.0)

**Table S1.** Experimental array of Series I. Tensile modulus and stress at break of PP fibers produced at different draw ratios, fumed silica contents (AR974) and compatibilizer contents (C).

| Run No. | Experimental | Factors |     | Tensile Modulus | Stress at Break |
|---------|--------------|---------|-----|-----------------|-----------------|
|         | Draw Ratio   | AR974   | C   | [GPa]           | [MPa]           |
| 1       | 1            | 0       | 0   | 0.48            | 83              |
| 2       | 4            | 0       | 0   | 1.55            | 289             |
| 3       | 5            | 0       | 0   | 1.7             | 374             |
| 4       | 7            | 0       | 0   | 2.5             | 522             |
| 5       | 10           | 0       | 0   | 5.3             | 944             |
| 6       | 12           | 0       | 0   | 6.5             | 1077            |
| 7       | 15           | 0       | 0   | 7.88            | 1240            |
| 8       | 17.4         | 0       | 0   | 8.5             | 1230            |
| 9       | 1            | 0       | 0.5 | 0.62            | 74.4            |
| 10      | 5            | 0       | 0.5 | 1.9             | 332             |
| 11      | 8.6          | 0       | 0.5 | 4.6             | 872             |
| 12      | 10           | 0       | 0.5 | 5.6             | 932             |
| 13      | 13.7         | 0       | 0.5 | 8.12            | 1058            |
| 14      | 15           | 0       | 0.5 | 8.8             | 1086            |
| 15      | 16           | 0       | 0.5 | 9.5             | 1125            |
| 16      | 20.5         | 0       | 0.5 | 11.5            | 1203            |
| 17      | 1            | 0       | 1   | 0.61            | 70              |
| 18      | 3.7          | 0       | 1   | 1.55            | 250             |
| 19      | 5            | 0       | 1   | 2               | 320             |
| 20      | 9.2          | 0       | 1   | 5.24            | 876             |
| 21      | 10           | 0       | 1   | 5.9             | 1068            |
| 22      | 12.8         | 0       | 1   | 8.5             | 1187            |
| 23      | 15           | 0       | 1   | 9.7             | 1213            |
| 24      | 17.4         | 0       | 1   | 10.5            | 1256            |
| 25      | 1            | 0.5     | 0   | 0.68            | 70              |
| 26      | 4            | 0.5     | 0   | 2.18            | 250             |
| 27      | 5            | 0.5     | 0   | 2.62            | 369             |
| 28      | 7            | 0.5     | 0   | 3.5             | 576             |
| 29      | 8            | 0.5     | 0   | 5.6             | 890             |
| 30      | 9            | 0.5     | 0   | 8.22            | 940             |
| 31      | 10           | 0.5     | 0   | 8.62            | 1054            |
| 32      | 12.8         | 0.5     | 0   | 9.15            | 1185            |
| 33      | 15           | 0.5     | 0   | 9.41            | 1237            |
| 34      | 1            | 0.5     | 0.5 | 0.6             | 70              |
| 35      | 4            | 0.5     | 0.5 | 1.55            | 267             |
| 36      | 5            | 0.5     | 0.5 | 1.79            | 370             |
| 37      | 6.25         | 0.5     | 0.5 | 2.1             | 497             |
| 38      | 7.3          | 0.5     | 0.5 | 2.6             | 644             |
| 39      | 8.2          | 0.5     | 0.5 | 4               | 772             |
| 40      | 10           | 0.5     | 0.5 | 5.8             | 976             |
| 41      | 13.7         | 0.5     | 0.5 | 8.4             | 1183            |
| 42      | 15           | 0.5     | 0.5 | 9.26            | 1211            |
| 43      | 1            | 0.5     | 1   | 0.66            | 70              |
| 44      | 4.3          | 0.5     | 1   | 1.78            | 398             |
| 45      | 5            | 0.5     | 1   | 2.44            | 485             |
| 46      | 8.6          | 0.5     | 1   | 5.2             | 933             |
| 47      | 10           | 0.5     | 1   | 7.04            | 1015            |
| 48      | 12           | 0.5     | 1   | 8.95            | 1118            |

1.1. Factorial Regression: Tensile Modulus [GPa] versus Draw Ratio; AR974; C

**Table S2.** Series I. Analysis of variance of tensile modulus versus draw ratio, fumed silica (AR974) and compatibilizer (C).

| Source                 | DF | Adj SS  | Adj MS  | F-Value | p-Value |
|------------------------|----|---------|---------|---------|---------|
| Model                  | 7  | 501.127 | 71.590  | 95.29   | 0.000   |
| Linear                 | 3  | 465.500 | 155.167 | 206.54  | 0.000   |
| Draw Ratio             | 1  | 439.247 | 439.247 | 584.67  | 0.000   |
| AR974                  | 1  | 7.206   | 7.206   | 9.59    | 0.004   |
| C                      | 1  | 0.451   | 0.451   | 0.60    | 0.443   |
| 2-Way Interactions     | 3  | 9.689   | 3.230   | 34.30   | 0.010   |
| Draw Ratio x AR974     | 1  | 2.835   | 2.835   | 3.77    | 0.059   |
| Draw Ratio x C         | 1  | 0.436   | 0.436   | 0.58    | 0.451   |
| AR974 x C              | 1  | 4.336   | 4.336   | 5.77    | 0.021   |
| 3-Way Interactions     | 1  | 0.703   | 0.703   | 0.94    | 0.339   |
| Draw Ratio x AR974 x C | 1  | 0.703   | 0.703   | 0.94    | 0.339   |
| Error                  | 40 | 30.051  | 0.751   |         |         |
| Total                  | 47 | 531.178 |         |         |         |

Model summary:  $S = 0.866763$ ;  $R\text{-sq} = 94.34\%$ ;  $R\text{-sq}(\text{adj}) = 93.35\%$ ;  $R\text{-sq}(\text{pred}) = 91.75\%$ .

**Table S3.** Series I. Analysis of tensile modulus. Coded coefficients, regression equation and alias structure.

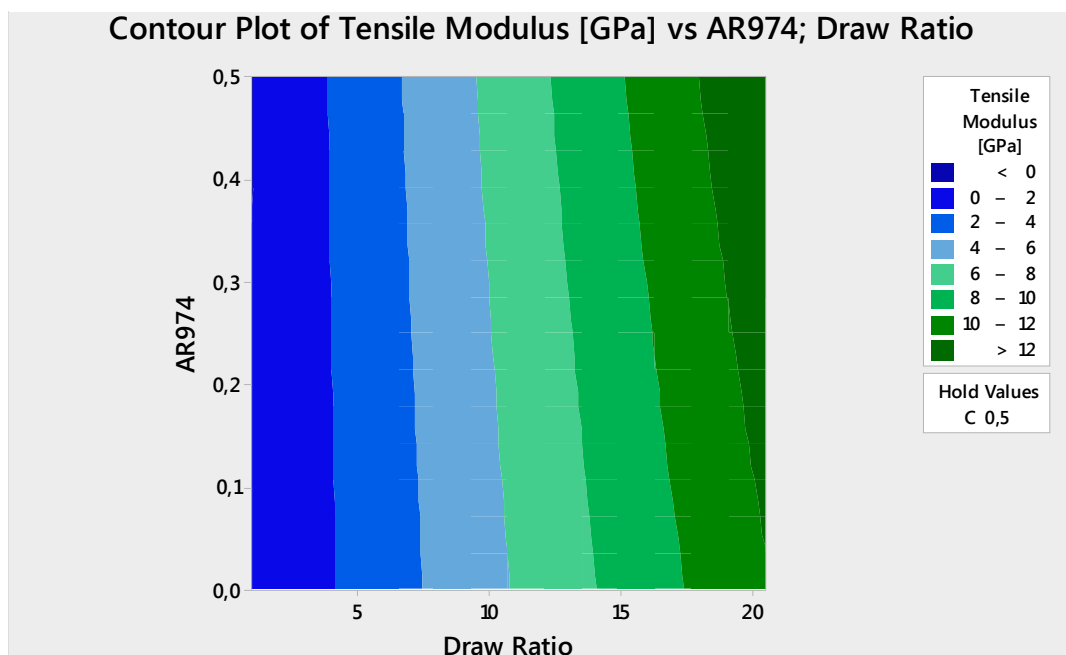
| Term                       | Effect | Coef                                                                                                                                                                                                                                                                                 | SE Coef | T-Value | p-Value | VIF  |
|----------------------------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------|---------|------|
| Constant                   |        | 6.397                                                                                                                                                                                                                                                                                | 0.147   | 43.61   | 0.000   |      |
| Draw Ratio                 | 12.831 | 6.415                                                                                                                                                                                                                                                                                | 0.265   | 24.18   | 0.000   | 1.20 |
| AR974                      | 0.909  | 3.10                                                                                                                                                                                                                                                                                 | 0.454   | 0.147   | 0.004   | 1.37 |
| C                          | 0.292  | 0.146                                                                                                                                                                                                                                                                                | 0.188   | 0.77    | 0.443   | 1.45 |
| Draw Ratio x AR974         | 1.031  | 0.515                                                                                                                                                                                                                                                                                | 0.265   | 1.94    | 0.059   | 1.34 |
| Draw Ratio x C             | 0.524  | 0.262                                                                                                                                                                                                                                                                                | 0.344   | 0.76    | 0.451   | 1.48 |
| AR974 x C                  | -0.905 | -0.452                                                                                                                                                                                                                                                                               | 0.344   | -2.40   | 0.021   | 1.45 |
| Draw Ratio x AR974 x C     | -0.665 | -0.332                                                                                                                                                                                                                                                                               | 0.188   | -0.97   | 0.339   | 1.48 |
| <b>Regression Equation</b> |        | <b>in Uncoded Units</b>                                                                                                                                                                                                                                                              |         |         |         |      |
| Tensile Modulus [GPa] =    |        | $-0.506 + (0.5442 \text{ Draw Ratio} - 0.11 \text{ AR974} - 0.114 \text{ C} + 0.348$<br>$\text{Draw Ratio} \times \text{AR974} + 0.1219 \text{ Draw Ratio} \times \text{C} -$<br>$0.69 \text{ AR974} \times \text{C} - 0.273 \text{ Draw Ratio} \times \text{AR974} \times \text{C}$ |         |         |         |      |
| <b>Alias Structure</b>     |        | <b>Factor Name *</b>                                                                                                                                                                                                                                                                 |         |         |         |      |
| Linear                     |        | A, B, C                                                                                                                                                                                                                                                                              |         |         |         |      |
| 2-Way Interactions         |        | AB, AC, BC                                                                                                                                                                                                                                                                           |         |         |         |      |

\*A = Draw Ratio; B = AR974; C = Compatibilizer

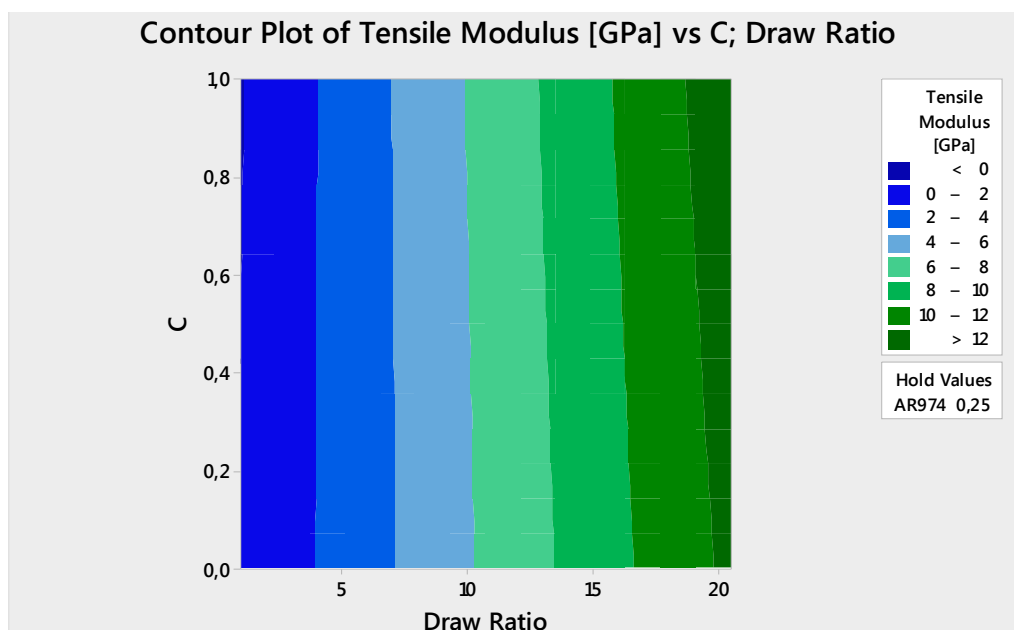
**Table S4.** Series I. Analysis of tensile modulus. Fits and diagnostics for unusual observations.

| Obs | Tensile Modulus [GPa] | Fit   | Resid  | Std Resid |
|-----|-----------------------|-------|--------|-----------|
| 30  | 8.220                 | 5.901 | 2.319  | 2.82 R    |
| 31  | 8.600                 | 6.619 | 1.981  | 2.43 R    |
| 38  | 2.600                 | 4.399 | -1.799 | -2.12 R   |
| 48  | 8.920                 | 7.424 | 1.496  | 2.12 R    |

R: Large residual.



**Figure S1.** Series I. Contour plot of tensile modulus [GPa] versus draw ratio and AR974 at constant C 0.5% by vol.



**Figure S2.** Series I. Contour plot of tensile modulus [GPa] versus draw ratio and C at constant AR974 0.25% by vol.

1.2. Factorial Regression: Stress at Break [MPa] versus Draw Ratio; AR974; C

**Table S5.** Series I. Analysis of variance of stress at break versus draw ratio, fumed silica (AR974) and compatibilizer (C).

| Source                 | DF | Adj SS    | Adj MS    | F-Value | p-Value |
|------------------------|----|-----------|-----------|---------|---------|
| Model                  | 7  | 7,469,665 | 1,067,095 | 68.49   | 0.000   |
| Linear                 | 3  | 7,194,005 | 2,398,002 | 153.91  | 0.000   |
| Draw Ratio             | 1  | 6,870,401 | 6,870,401 | 440.95  | 0.000   |
| AR974                  | 1  | 165,177   | 165,177   | 10.60   | 0.002   |
| C                      | 1  | 9030      | 9030      | 0.58    | 0.451   |
| 2-Way Interactions     | 3  | 117,151   | 39,050    | 2.51    | 0.073   |
| Draw Ratio * AR974     | 1  | 114,857   | 114,857   | 7.37    | 0.010   |
| Draw Ratio * C         | 1  | 830       | 830       | 0.05    | 0.819   |
| AR974 * C              | 1  | 2         | 2         | 0.00    | 0.990   |
| 3-Way Interactions     | 1  | 229       | 229       | 0.01    | 0.904   |
| Draw Ratio * AR974 * C | 1  | 229       | 229       | 0.01    | 0.904   |
| Error                  | 40 | 623,229   | 15,581    |         |         |
| Total                  | 47 | 8,092,894 |           |         |         |

Model summary: S = 124.823; R-sq = 92.30%; R-sq(adj) = 90.95%; R-sq(pred) = 89.13%.

**Table S6.** Series I. Analysis of stress at break. Coded coefficients, regression equation and alias structure.

| Term                   | Effect | Coef  | SE Coef | T-Value | p-Value | VIF  |
|------------------------|--------|-------|---------|---------|---------|------|
| Constant               |        | 914.7 | 21.1    | 43.30   | 0.000   |      |
| Draw Ratio             | 1604.7 | 802.3 | 38.2    | 21.00   | 0.000   | 1.20 |
| AR974                  | 137.6  | 68.8  | 21.1    | 3.26    | 0.002   | 1.37 |
| C                      | 41.3   | 20.6  | 27.1    | 0.76    | 0.451   | 1.45 |
| Draw Ratio x AR974     | 207.5  | 103.7 | 38.2    | 2.72    | 0.010   | 1.34 |
| Draw Ratio x C         | 22.9   | 11.4  | 49.5    | 0.23    | 0.819   | 1.48 |
| AR974 x C              | -0.7   | -0.3  | 27.1    | -0.01   | 0.990   | 1.45 |
| Draw Ratio x AR974 x C | -12.0  | -6.0  | 49.5    | -0.12   | 0.904   | 1.48 |

| Regression Equation     | in Uncoded Units                                                                                                                     |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Stress at break [MPa] = | 73.9 + 69.86 Draw Ratio - 208 AR974 + 4 C + 45.0 Draw Ratio x AR974 + 3.6 Draw Ratio x C + 50 AR974 x C - 4.9 Draw Ratio x AR974 x C |

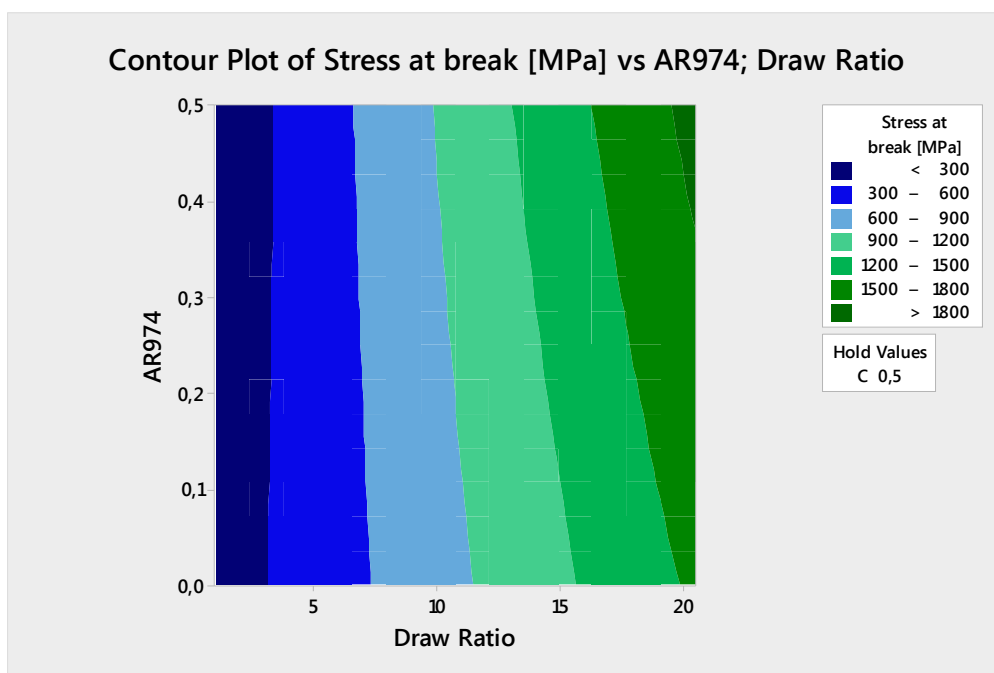
| Alias Structure    | Factor Name * |
|--------------------|---------------|
| Linear             | A, B, C       |
| 2-Way Interactions | AB, AC, BC    |
| 3-Way Interactions | ABC           |

\* A = Draw Ratio; B = AR974; C = Compatibilizer

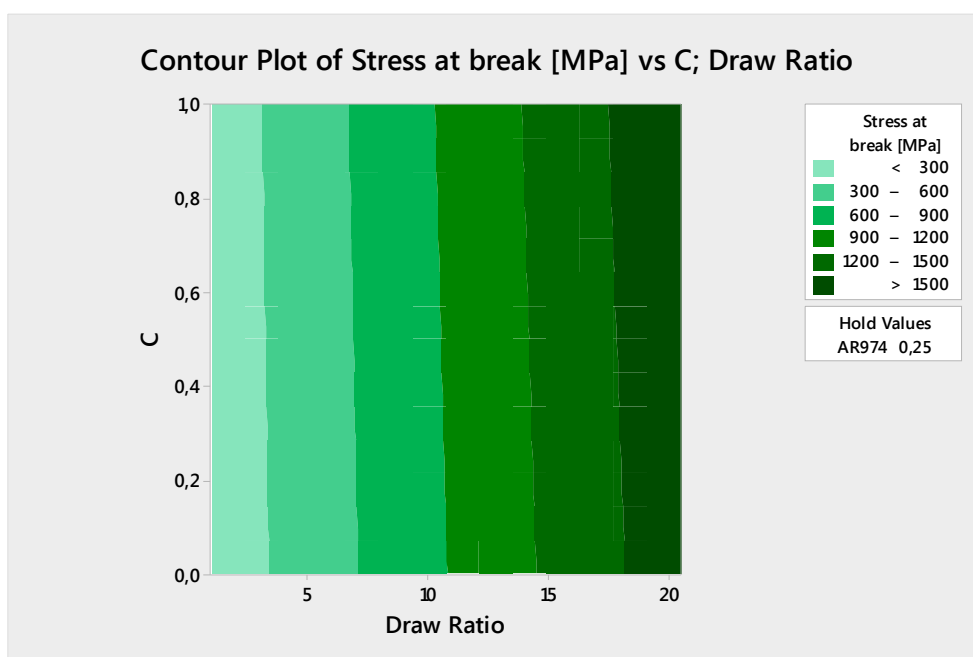
**Table S7.** Series I. Analysis of stress at break. Fits and diagnostics for unusual observations.

| Obs | Stress at break [MPa] | Fit    | Resid  | Std resid |
|-----|-----------------------|--------|--------|-----------|
| 16  | 1203.0                | 1544.5 | -341.5 | -3.04 R   |
| 21  | 1068.0                | 811.8  | 256.2  | 2.17 R    |

R: Large residual.



**Figure S3.** Series I. Contour plot of stress at break [MPa] versus draw ratio and AR974 at constant C 0.5% by vol.



**Figure S4.** Series I. Contour plot of stress at break [MPa] versus draw ratio and C at constant AR974 0.25% by vol.

## 2. Statistical Analysis of Series II (Minitab 17 Software, Release 3.1.0)

**Table S8.** Experimental array of Series II. Tensile modulus, tenacity, and stress at break of PP fibers produced at different draw ratios and fumed silica contents (AR974).

| Run No. | Experimental Draw Ratio | Factors AR974 | Tensile Modulus [GPa] | Tenacity [cN/tex] | Stress at Break [MPa] |
|---------|-------------------------|---------------|-----------------------|-------------------|-----------------------|
| 1       | 1                       | 0             | 0.48                  | 9.2               | 83                    |
| 2       | 1                       | 0.25          | 0.58                  | 8.2               | 74                    |
| 3       | 1                       | 0.5           | 0.68                  | 7.7               | 70                    |
| 4       | 1                       | 1             | 0.65                  | 9.1               | 83                    |
| 5       | 1                       | 2             | 0.67                  | 6.7               | 62                    |
| 6       | 5                       | 0             | 1.71                  | 41.3              | 374                   |
| 7       | 5                       | 0.25          | 2.45                  | 55.4              | 503                   |
| 8       | 5                       | 0.5           | 2.62                  | 40.5              | 369                   |
| 9       | 5                       | 1             | 2.41                  | 48.3              | 442                   |
| 10      | 5                       | 2             | 1.81                  | 37.3              | 346                   |
| 11      | 10                      | 0             | 5.3                   | 104.3             | 944                   |
| 12      | 10                      | 0.25          | 7.5                   | 127               | 1153                  |
| 13      | 10                      | 0.5           | 8.62                  | 115.8             | 1054                  |
| 14      | 10                      | 1             | 5.7                   | 99.9              | 915                   |
| 15      | 10                      | 2             | 4.1                   | 85.8              | 795                   |
| 16      | 15                      | 0             | 7.88                  | 137               | 1240                  |
| 17      | 15                      | 2.5           | 8.3                   | 135.5             | 1230                  |
| 18      | 15                      | 0.5           | 9.41                  | 135.9             | 1237                  |
| 19      | 15                      | 1             | 8.1                   | 137.1             | 1256                  |
| 20      | 15                      | 2             | 6.5                   | 123.6             | 1145                  |

### 2.1. Factorial Regression: Tensile Modulus [GPa] versus Draw Ratio; AR974; C

**Table S9.** Series II. Analysis of variance of tensile modulus versus draw ratio and fumed silica (AR974).

| Source             | DF | Adj SS  | Adj MS  | F-Value | p-Value |
|--------------------|----|---------|---------|---------|---------|
| Model              | 3  | 179.740 | 59.913  | 56.00   | 0.000   |
| Linear             | 2  | 147.350 | 73.675  | 68.87   | 0.000   |
| Draw Ratio         | 1  | 143.097 | 143.097 | 133.76  | 0.000   |
| AR974              | 1  | 3.508   | 3.508   | 3.28    | 0.089   |
| 2-Way Interactions | 3  | 2.131   | 2.131   | 1.99    | 0.177   |
| Draw Ratio x AR974 | 1  | 2.131   | 2.131   | 1.99    | 0.177   |
| Error              | 16 | 17.117  | 1.070   |         |         |
| Total              | 19 | 196.857 |         |         |         |

Model summary:  $S = 1.03430$ ;  $R\text{-sq} = 91.31\%$ ;  $R\text{-sq}(\text{adj}) = 89.67\%$ ;  $R\text{-sq}(\text{pred}) = 88.15\%$ .

**Table S10.** Series II. Analysis of tensile modulus. Coded coefficients, regression equation and alias structure.

| Term               | Effect | Coef   | SE Coef | T-Value | p-Value | VIF  |
|--------------------|--------|--------|---------|---------|---------|------|
| Constant           |        | 4.266  | 0.246   | 17.37   | 0.000   |      |
| Draw Ratio         | 7.549  | 3.774  | 0.326   | 11.57   | 0.000   | 1.13 |
| AR974              | -1.186 | -0.593 | 0.327   | -1.81   | 0.089   | 1.00 |
| Draw Ratio x AR974 | -1.228 | -0.614 | 0.435   | -1.41   | 0.177   | 1.13 |

**Regression Equation** **in Uncoded Units**

$$\text{Tensile Modulus [GPa]} = -0.157 + 0.6269 \text{ Draw Ratio} + 0.109 \text{ AR974} - 0.0877 \text{ Draw Ratio} \times \text{AR974}$$

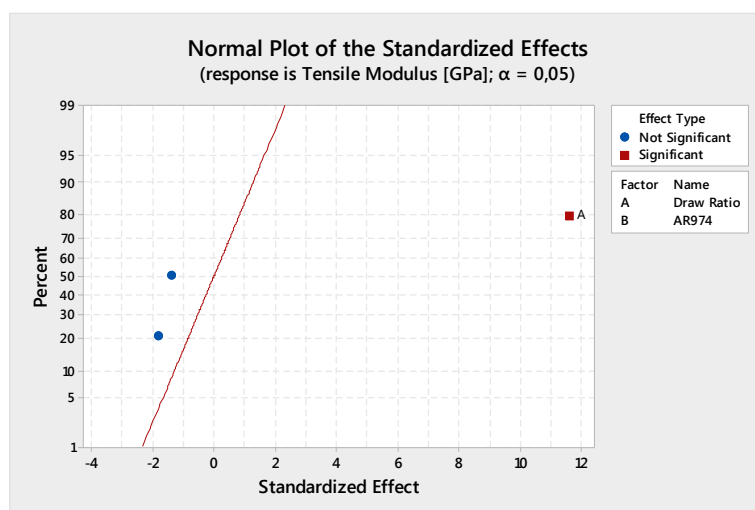
| Alias Structure    | Factor Name * |
|--------------------|---------------|
| Linear             | A, B          |
| 2-Way Interactions | AB            |

\* A = Draw Ratio; B = AR974.

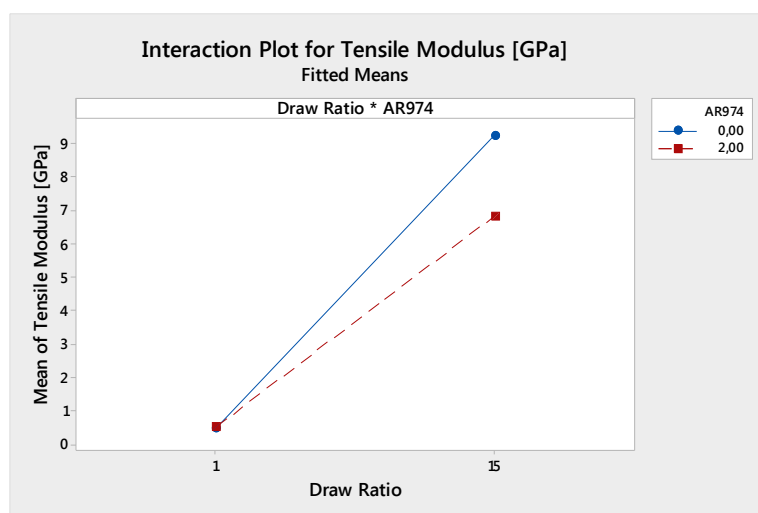
**Table S11.** Series II. Analysis of tensile modulus. Fits and diagnostics for unusual observations.

| Obs | Tensile Modulus [GPa] | Fit   | Resid | Std Resid |
|-----|-----------------------|-------|-------|-----------|
| 13  | 8.620                 | 5.728 | 2.892 | 2.89 R    |

R: Large residual.



**Figure S5.** Series II. Normal plot of the standardized effects for tensile modulus [GPa].



**Figure S6.** Interaction plot for tensile modulus [GPa] in Series II.

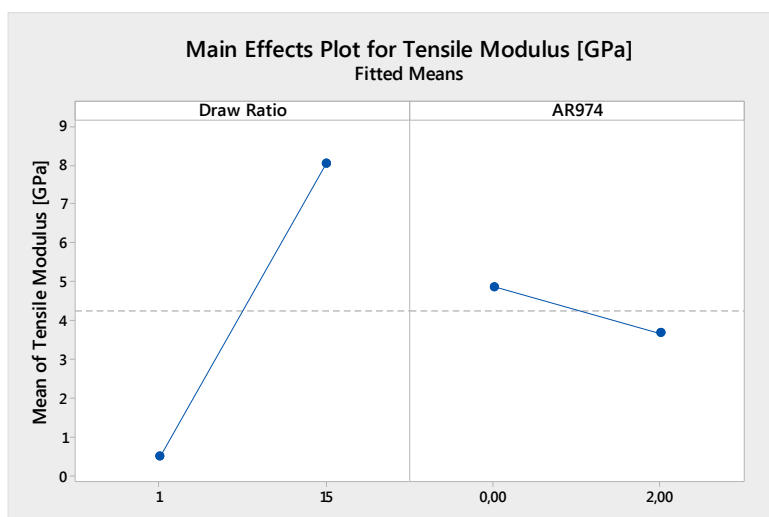


Figure S7. Main effects plot for tensile modulus [GPa] in Series II.

2.2. Factorial Regression: Tenacity [cN/tex] versus Draw Ratio; AR974

Table S12. Series II. Analysis of variance of tenacity versus draw ratio and fumed silica (AR974).

| Source             | DF | Adj SS  | Adj MS  | F-Value | p-Value |
|--------------------|----|---------|---------|---------|---------|
| Model              | 3  | 48632.8 | 16210.9 | 138.23  | 0.000   |
| Linear             | 2  | 42073.4 | 21036.7 | 179.38  | 0.000   |
| Draw Ratio         | 1  | 41464.0 | 41464.0 | 353.56  | 0.000   |
| AR974              | 1  | 460.6   | 460.6   | 3.93    | 0.065   |
| 2-Way Interactions | 3  | 89.3    | 89.3    | 0.76    | 0.396   |
| Draw Ratio x AR974 | 1  | 89.3    | 89.3    | 0.76    | 0.396   |
| Error              | 16 | 1876.4  | 117.3   |         |         |
| Total              | 19 | 50509.2 |         |         |         |

Model Summary: S = 10.8293; R-sq = 96.29%; R-sq(adj) = 95.59%; R-sq(pred) = 94.99%.

Table S13. Series II. Analysis of tenacity. Coded coefficients, regression equation and alias structure.

| Term                       | Effect   | Coef                                                               | SE Coef | T-Value | p-Value | VIF  |
|----------------------------|----------|--------------------------------------------------------------------|---------|---------|---------|------|
| Constant                   |          | 73.91                                                              | 2.57    | 28.74   | 0.000   |      |
| Draw Ratio                 | 128.49   | 64.25                                                              | 3.42    | 18.80   | 0.000   | 1.13 |
| AR974                      | -13.59   | -6.79                                                              | 3.43    | -1.98   | 0.065   | 1.00 |
| Draw Ratio x AR974         | è7 -7.95 | -3.97                                                              | 4.56    | -0.87   | 0.396   | 1.13 |
| <b>Regression Equation</b> |          | <b>in Uncoded Units</b>                                            |         |         |         |      |
| Tenacity[cN/tex] =         |          | 2.74 + 9.746 Draw Ratio - 2.25 AR974 -<br>0.568 Draw Ratio x AR974 |         |         |         |      |
| <b>Alias Structure</b>     |          | <b>Factor Name *</b>                                               |         |         |         |      |
| Linear                     |          | A, B                                                               |         |         |         |      |
| 2-Way Interactions         |          | AB                                                                 |         |         |         |      |

\* A= Draw Ratio; B = AR974.

Table S14. Series II. Analysis of tenacity. Fits and diagnostics for unusual observations.

| Obs | Tenacity [cN/tex] | Fit   | Resid | Std Resid |
|-----|-------------------|-------|-------|-----------|
| 12  | 127.00            | 98.22 | 28.78 | 2.78 R    |

R: Large residual.



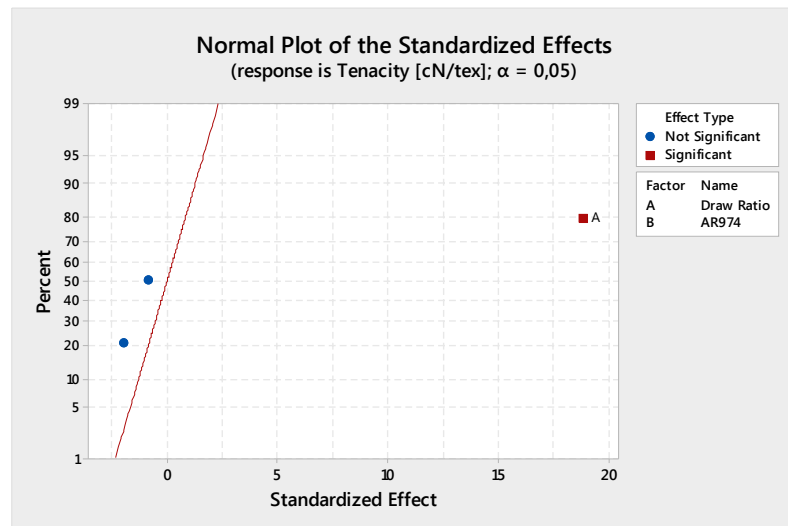


Figure S8. Series II. Normal plot for tenacity [cN/tex].

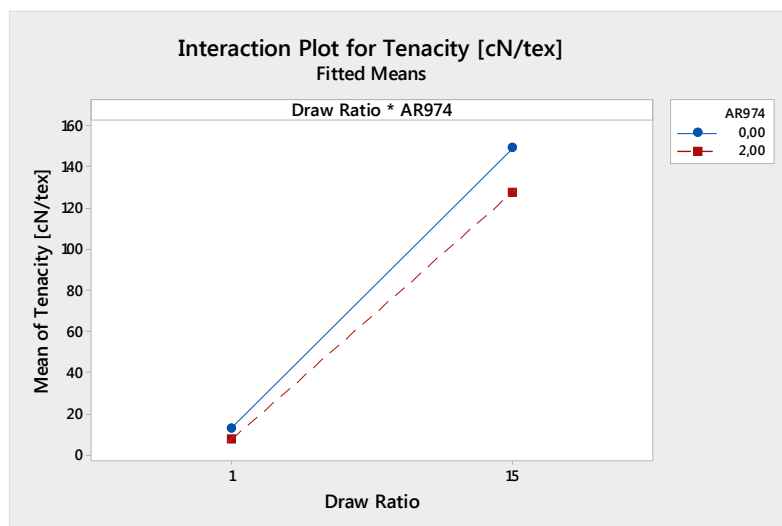


Figure S9. Interaction plot for tenacity [cN/tex] in Series II.

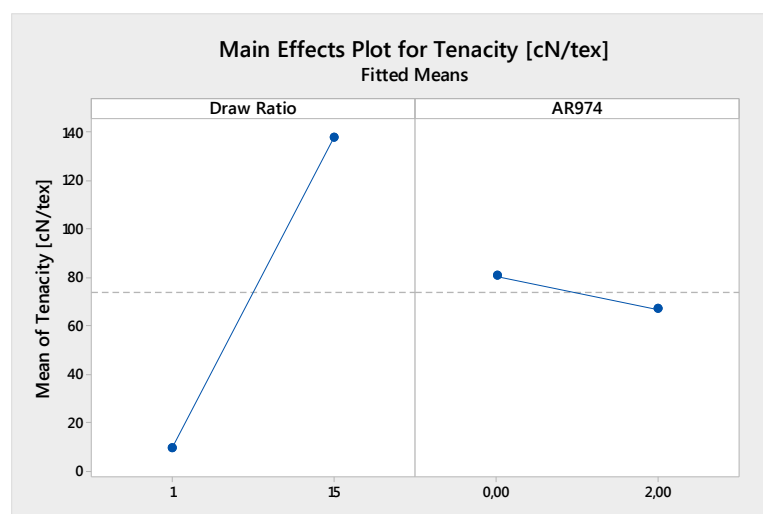


Figure S10. Main effects plot for tenacity [cN/tex] in Series II.

2.3. Factorial Regression: Stress at Break [MPa] versus Draw Ratio; AR974

**Table S15.** Series II. Analysis of variance of stress at break versus draw ratio and fumed silica (AR974).

| Source             | DF | Adj SS    | Adj MS    | F-Value | p-Value |
|--------------------|----|-----------|-----------|---------|---------|
| Model              | 3  | 4,042,361 | 1,347,454 | 138.94  | 0.000   |
| Linear             | 2  | 3,515,800 | 1,757,900 | 181.26  | 0.000   |
| Draw Ratio         | 1  | 3,475,150 | 3,475,150 | 358.33  | 0.000   |
| AR974              | 1  | 29,620    | 29,620    | 3.05    | 0.100   |
| 2-Way Interactions | 3  | 4981      | 4981      | 0.51    | 0.484   |
| Draw Ratio x AR974 | 1  | 4981      | 4981      | 0.51    | 0.484   |
| Error              | 16 | 155,173   | 9698      |         |         |
| Total              | 19 | 4,197,534 |           |         |         |

Model summary: S = 98.4800; R-sq = 96.30%; R-sq(adj) = 95.61%; R-sq(pred) = 95.00%.

**Table S16.** Series II. Analysis of stress at break. Coded coefficients, regression equation and alias structure.

| Term                       | Effect | Coef                                                              | SE Coef | T-Value | p-Value | VIF  |
|----------------------------|--------|-------------------------------------------------------------------|---------|---------|---------|------|
| Constant                   |        | 676.4                                                             | 23.4    | 28.93   | 0.000   |      |
| Draw Ratio                 | 1176.3 | 588.2                                                             | 31.1    | 18.93   | 0.000   | 1.13 |
| AR974                      | -109.0 | -54.5                                                             | 31.2    | -1.75   | 0.100   | 1.00 |
| Draw Ratio x AR974         | -59.4  | -29.7                                                             | 41.4    | -0.72   | 0.484   | 1.13 |
| <b>Regression Equation</b> |        | <b>in Uncoded Units</b>                                           |         |         |         |      |
| Tenacity [MPa] =           |        | 24.8 + 88.27 Draw Ratio - 20.6 AR974 -<br>4.24 Draw Ratio x AR974 |         |         |         |      |
| <b>Alias Structure</b>     |        | <b>Factor Name *</b>                                              |         |         |         |      |
| Linear                     |        | A, B                                                              |         |         |         |      |
| 2-Way Interactions         |        | AB                                                                |         |         |         |      |

\* A = Draw Ratio; B = AR974.

**Table S17.** Series II. Analysis of stress at break Fits and diagnostics for unusual observations.

| Obs | Stress at break [MPa] | Fit   | Resid | Std Resid |
|-----|-----------------------|-------|-------|-----------|
| 12  | 1153.0                | 891.7 | 261.3 | 2.78 R    |

R: Large residual.

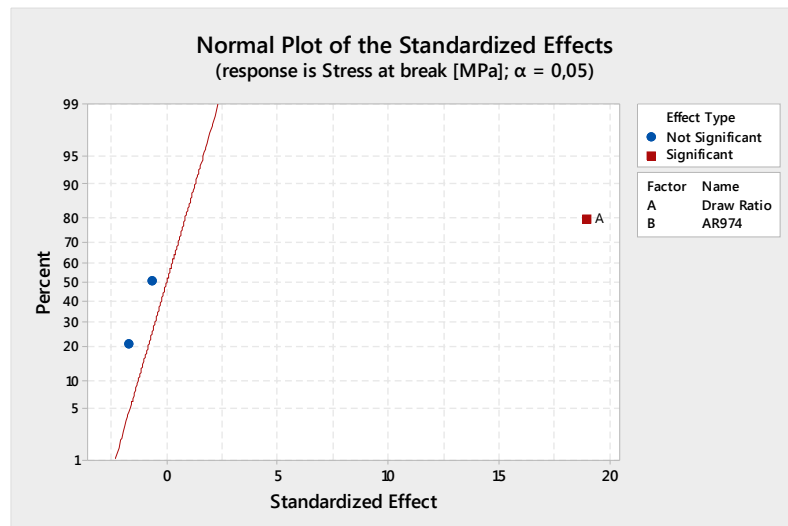


Figure S11. Series II. Normal plot for stress at break [MPa].

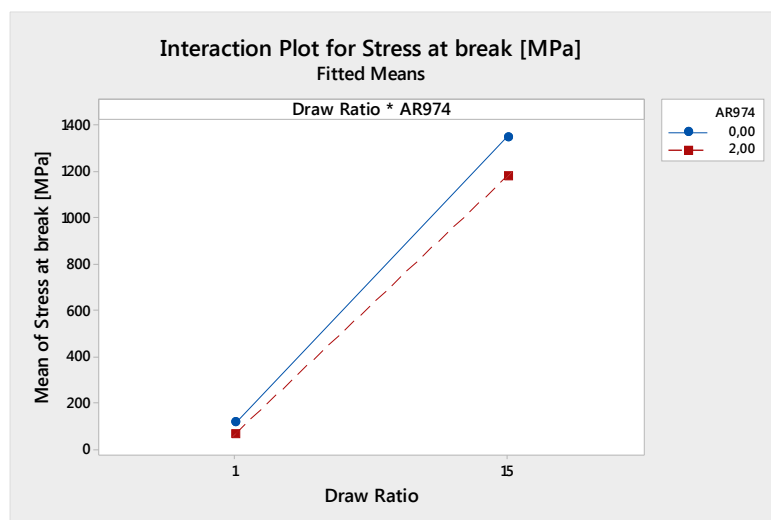


Figure S12. Interaction plot for stress at break [MPa] in Series II.

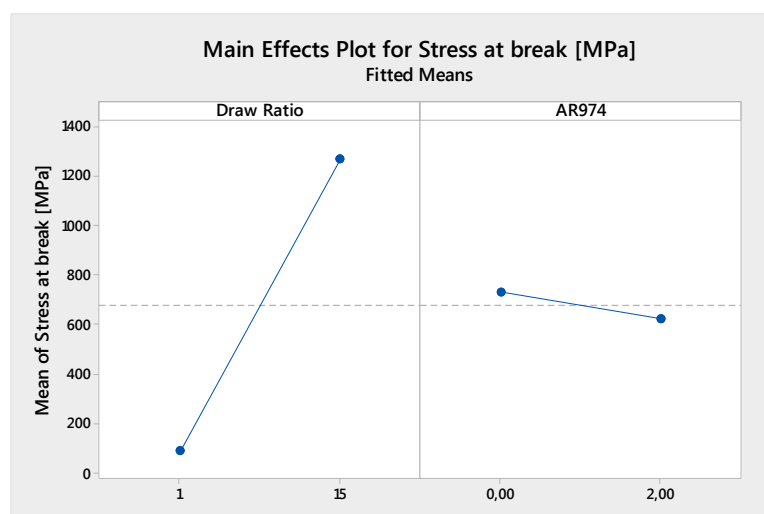


Figure S13. Main effects plot for stress at break [MPa] in Series II.