

## Introduction

Polymerization shrinkage stress in dental composite resins occurs when curing causes the material to contract as molecular distances shorten. This can result in issues such as debonding, marginal gaps, and cuspal movement. Managing shrinkage stress is crucial for ensuring durable and long-lasting restorations.

## Objective

To compare mechanical properties related to polymerization shrinkage of novel light curing dental composites

## Materials and methods

### Materials used

Five commercially flowable composites with two experimental composites, were evaluated

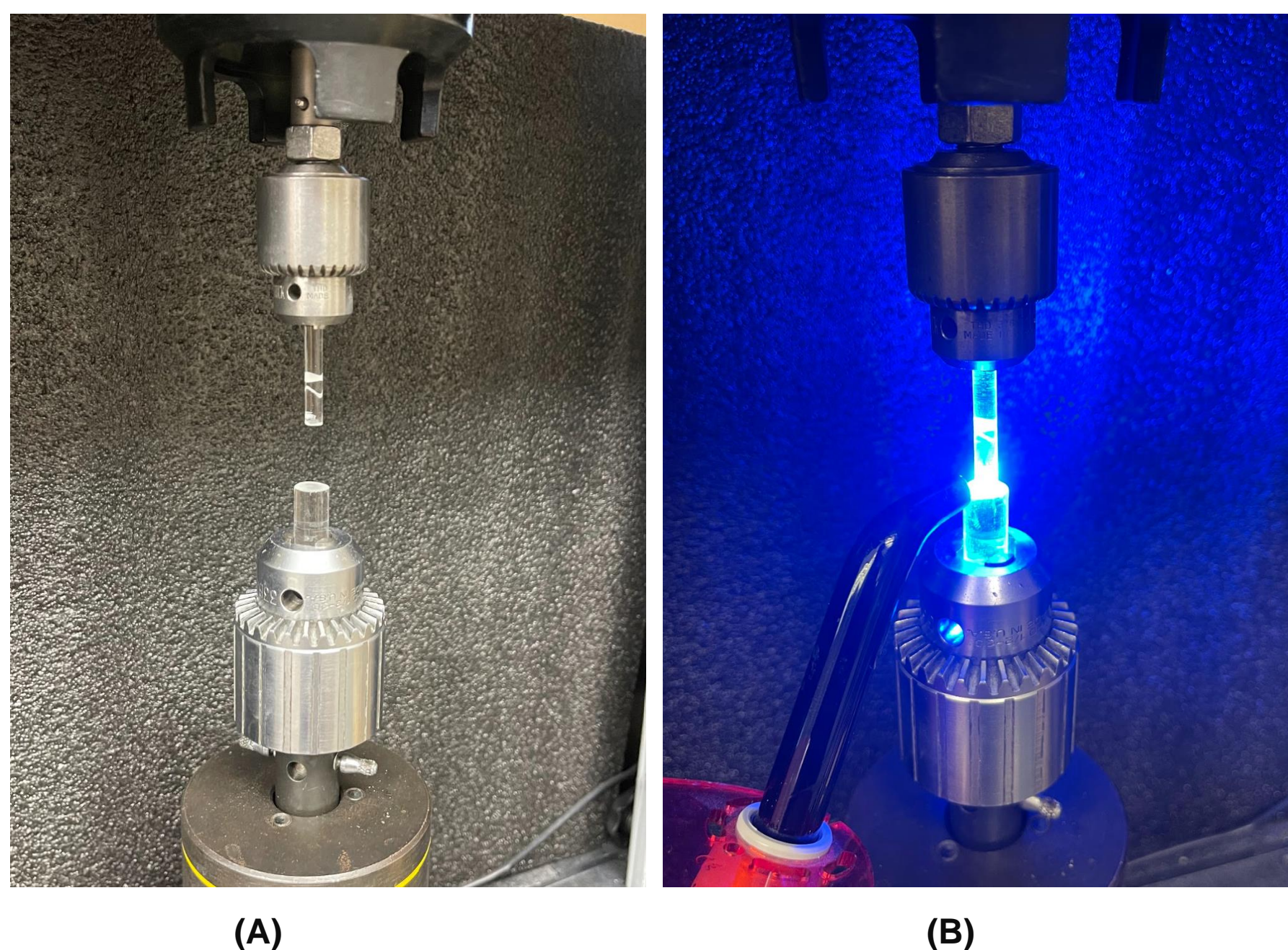
1. 3M Filtek Bulkfill Flowable Restorative (Lot: 1072225, Solventum)
2. SDR Flow+ Bulk Fill composite (Lot: 2403000308, Dentsply Sirona)
3. Gradia Direct Flo Shade A2 (Lot: 2308181, GC)
4. Omnichroma Flow Bulk (Lot: 029614, Tokuyama)
5. ACTIVA™ BioACTIVE Bulk Flow (Lot: 240501, Pulpdent)
6. Pulpdent Experimental B (Lot: 240409, Pulpdent)
7. Pulpdent Experimental C (Lot: 240501, Pulpdent)



**Figure 1.** Picture of material used in this experiment 1) 3M Filtek Bulkfill Flowable Restorative, 2. SDR Flow+ Bulk Fill, 3. Gradia Direct Flo, 4. Omnichroma Flow Bulk, 5. Activa Bioactive Bulk Flow

### Specimen Fabrication

- The silica rod surfaces were polished with a 70 micron diamond grinding disk and treated with 3M Scotch bond Universal Plus adhesive (Lot: 7910512, Solventum).
- Composite resin cylinders (1.5xΦ5mm) were built between two fused silica rods connected to a Universal Mechanical Tester's load cells.



### Testing conditions

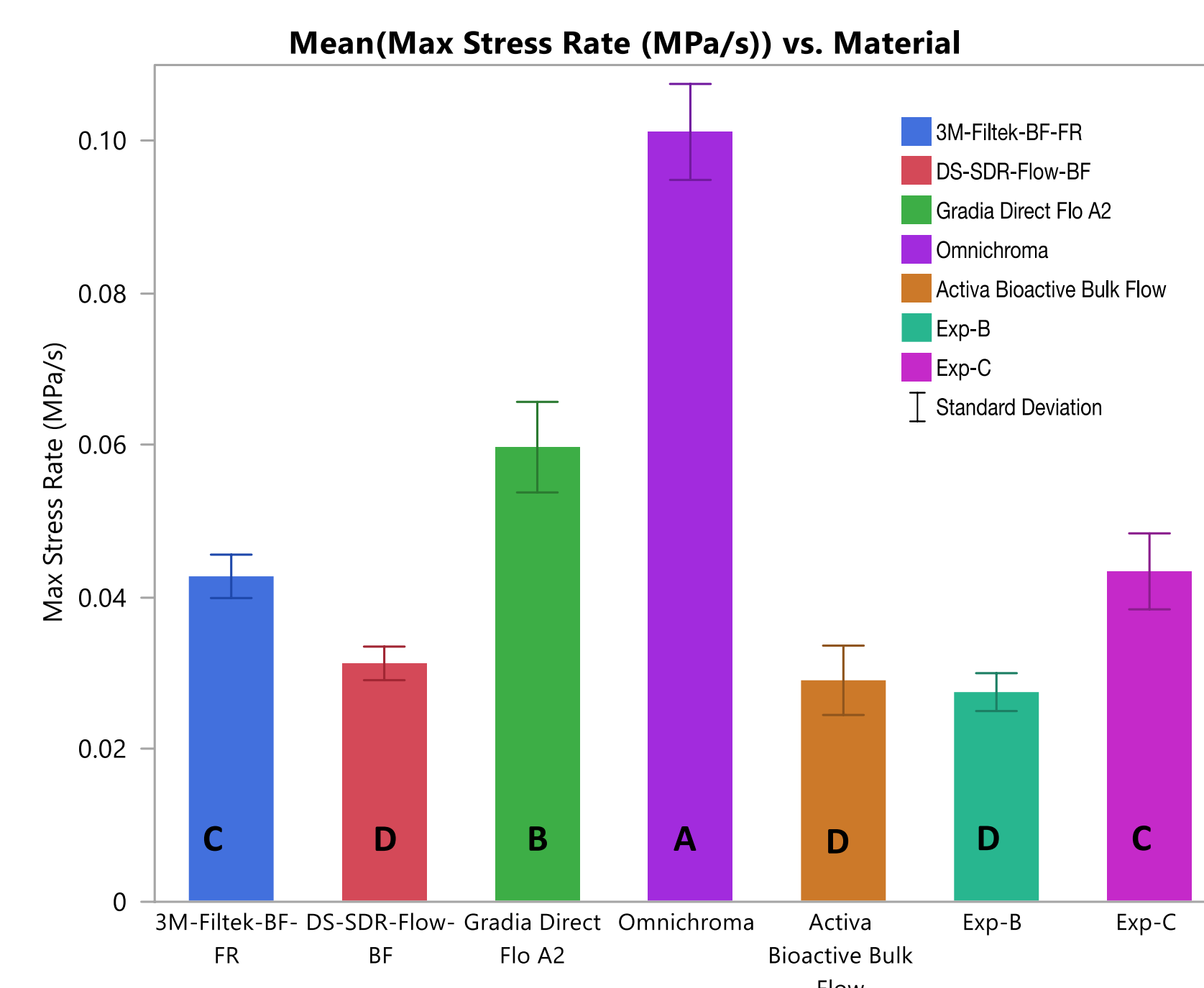
- The Universal Mechanical Tester with 100N load cell (Instron 5566A) was used as shown in picture (A). After relaxation for 1 min, the composite resin cylinders were light-cured for 20 second using Demi Plus (Kerr) light curing unit as shown in picture (A)
- The polymerization-induced retraction force was recorded by Bluehill Universal for 320 seconds. Shrinkage stress rate was calculated by stress change in nearby 2 seconds.
- Statistical analysis was performed using one-way ANOVA ( $\alpha=0.05$ ) with JMP Pro software.

## Result

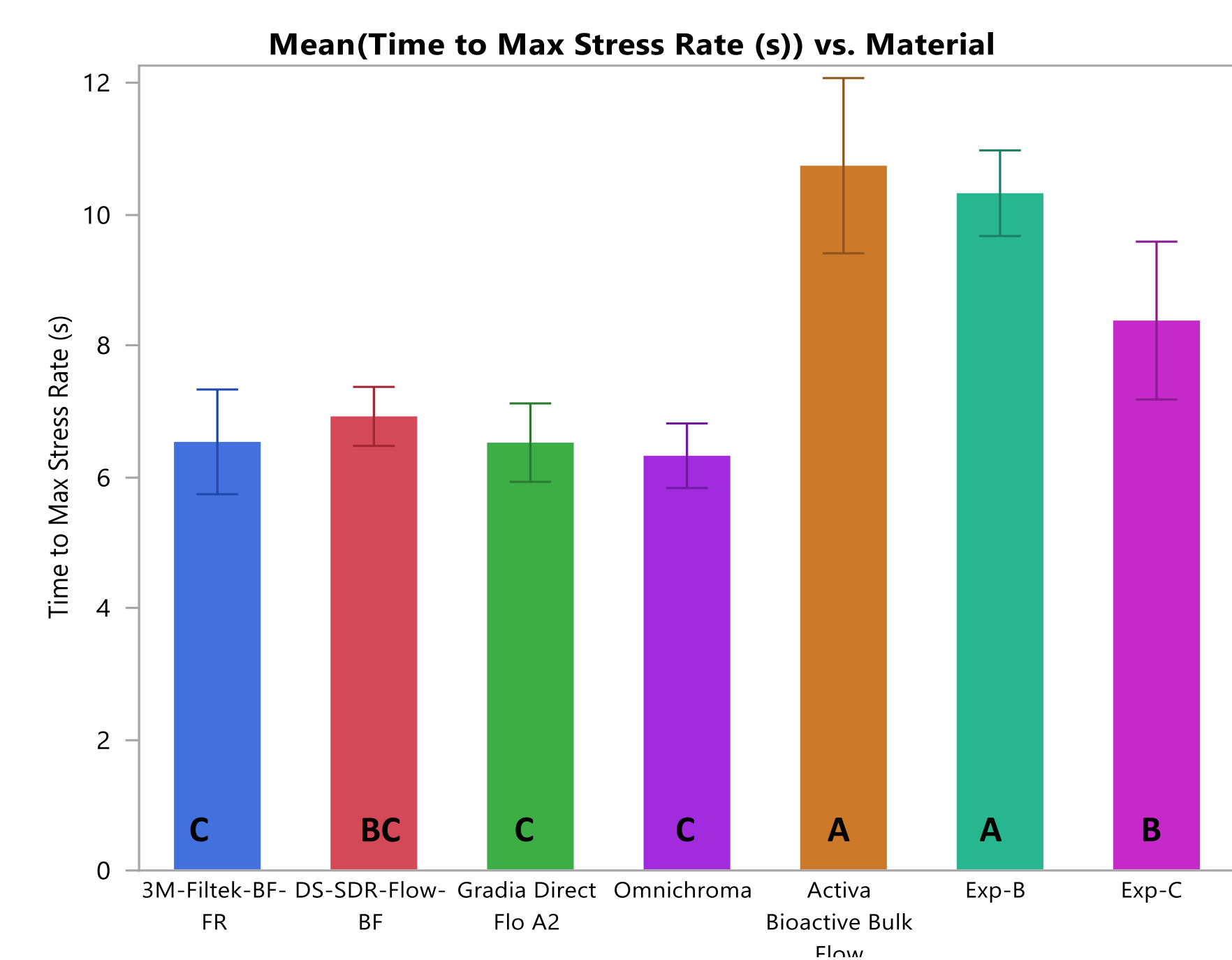
**Table 1.** The shrinkage stress, maximum shrinkage stress rate, and time to reach the maximum shrinkage stress rate of tested resin composites.

| Material                    | Max Stress Rate (MPa/s) |                     |      | Time to Max Stress Rate (s) |                  |      | Max Shrinkage Stress (MPa) |                   |      |
|-----------------------------|-------------------------|---------------------|------|-----------------------------|------------------|------|----------------------------|-------------------|------|
|                             | N                       | Mean $\pm$ SD       | Sig* | N                           | Mean $\pm$ SD    | Sig* | N                          | Mean $\pm$ SD     | Sig* |
| 3M-Filtek-BF-FR             | 5                       | 0.0428 $\pm$ 0.0029 | C    | 5                           | 6.53 $\pm$ 0.80  | C    | 5                          | 0.634 $\pm$ 0.039 | C    |
| DS-SDR-Flow-BF              | 5                       | 0.0313 $\pm$ 0.0022 | D    | 5                           | 6.92 $\pm$ 0.45  | BC   | 5                          | 0.524 $\pm$ 0.024 | D    |
| Gradia Direct Flo A2        | 5                       | 0.0597 $\pm$ 0.0060 | B    | 5                           | 6.52 $\pm$ 0.60  | C    | 5                          | 0.844 $\pm$ 0.044 | B    |
| Omnichroma                  | 5                       | 0.1012 $\pm$ 0.0063 | A    | 5                           | 6.32 $\pm$ 0.49  | C    | 5                          | 0.978 $\pm$ 0.018 | A    |
| ACTIVA™ BioACTIVE Bulk Flow | 5                       | 0.0291 $\pm$ 0.0046 | D    | 5                           | 10.74 $\pm$ 1.34 | A    | 5                          | 0.670 $\pm$ 0.052 | C    |
| Exp-B                       | 5                       | 0.0276 $\pm$ 0.0025 | D    | 5                           | 10.32 $\pm$ 0.64 | A    | 5                          | 0.625 $\pm$ 0.045 | C    |
| Exp-C                       | 5                       | 0.0434 $\pm$ 0.0050 | C    | 5                           | 8.38 $\pm$ 1.20  | B    | 5                          | 0.788 $\pm$ 0.042 | B    |

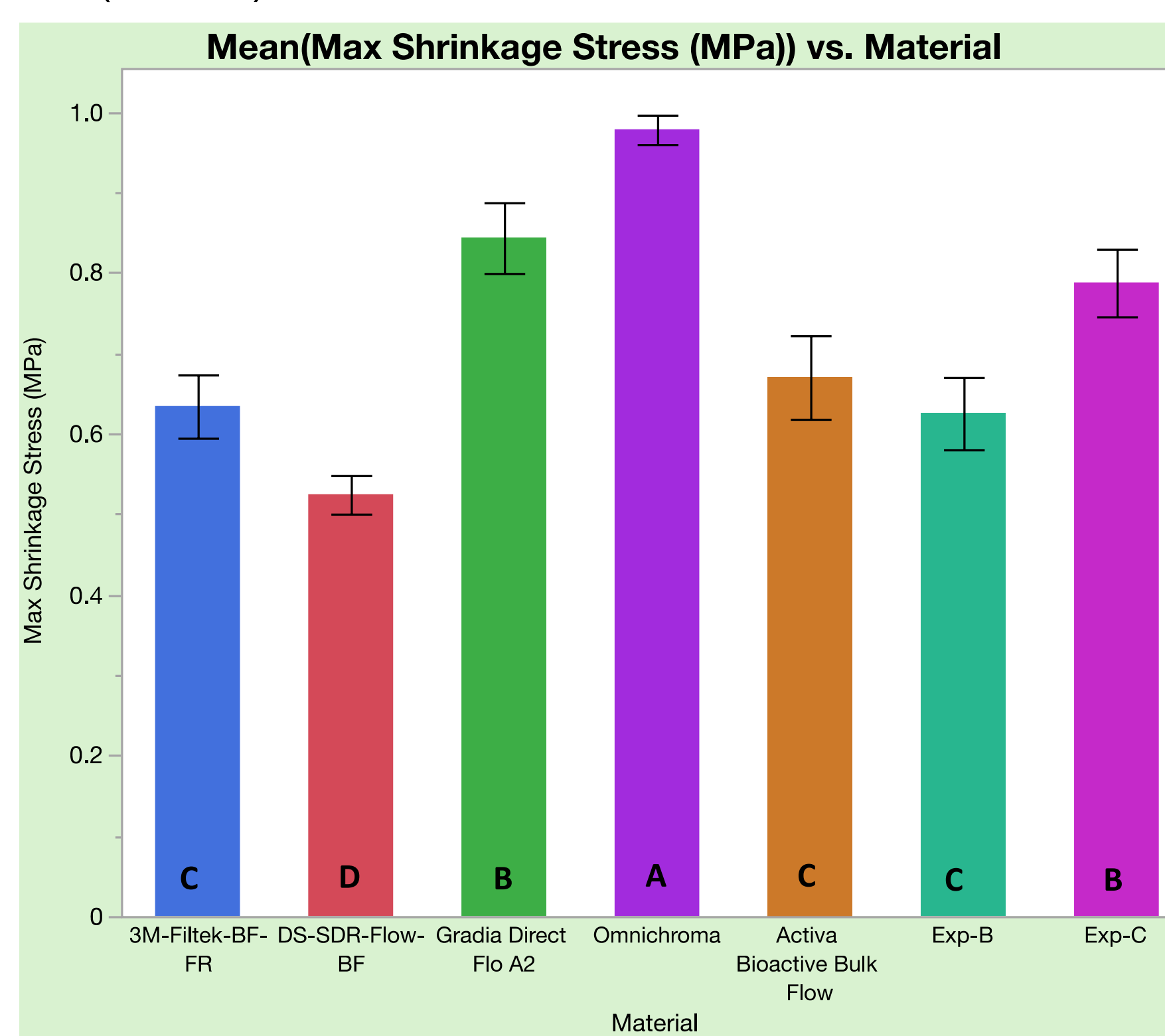
\* In each parameter, levels not connected by same letters are significant different ( $p<0.05$ ).



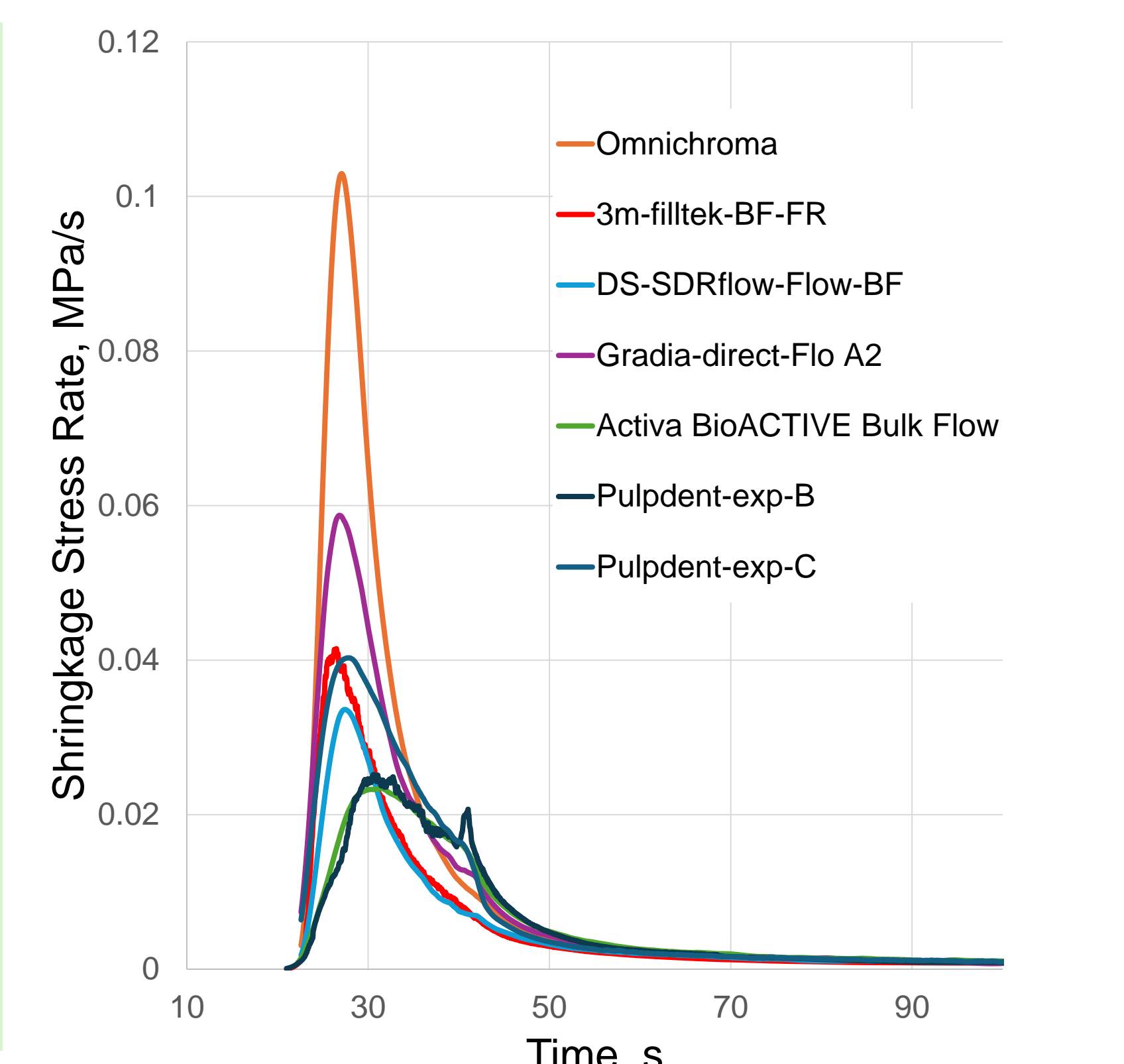
**Figure 2.** Polymerization shrinkage stress rate (MPa/s) vs Material



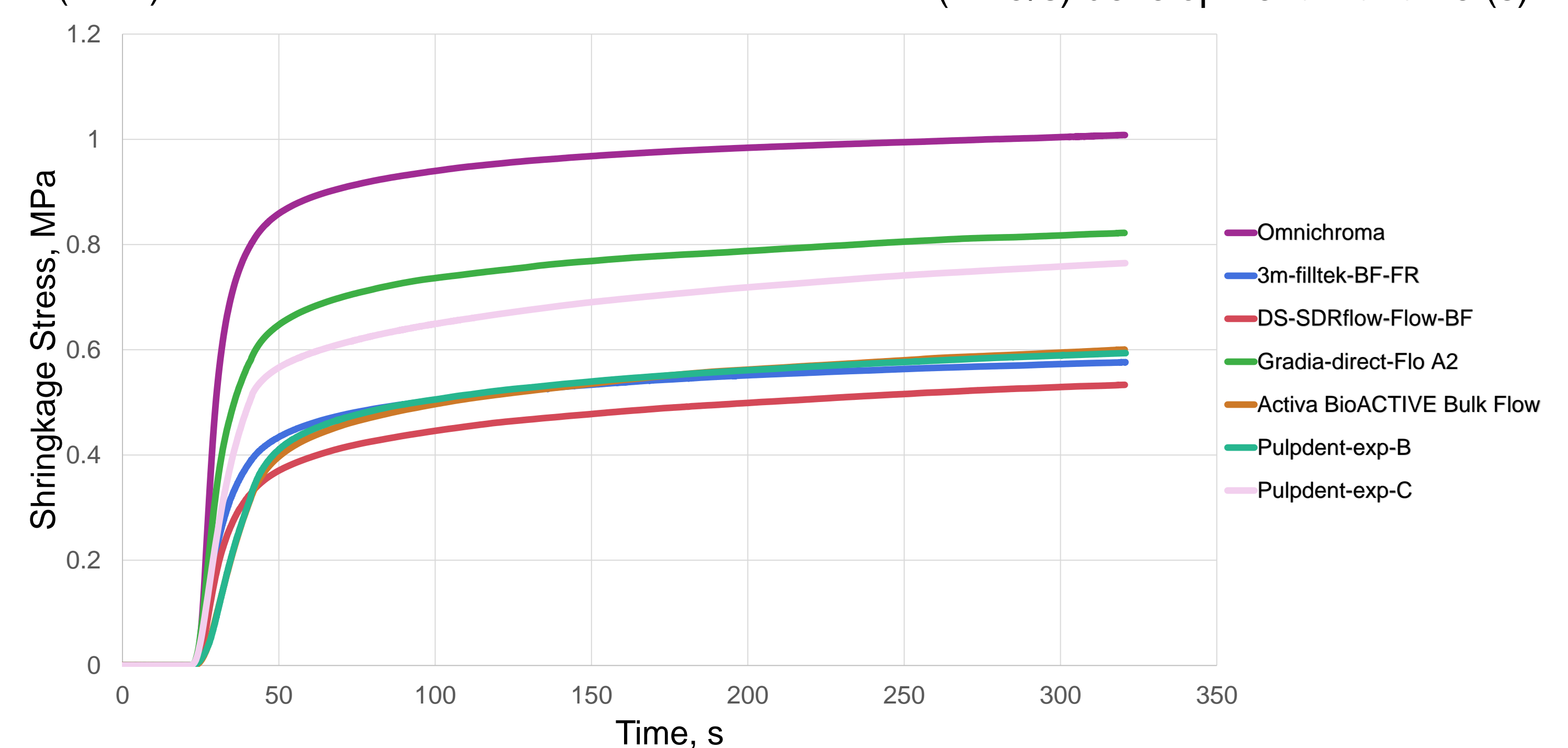
**Figure 3.** Polymerization time to max shrinkage stress rate (MPa/s) vs Material



**Figure 4.** Maximum polymerization shrinkage stress (MPa) vs. Material



**Figure 5.** Polymerization shrinkage stress rate (MPa/s) development with time (s)



**Figure 6.** Polymerization shrinkage stress (MPa) development with time (s) during the curing process.

## Conclusion

Omnichroma composite exhibited the shortest time to reach maximum and highest shrinkage stress rates. SDR Flow+ Bulk Fill demonstrated the lowest maximum shrinkage stress among the tested materials. Activa Bioactive Bulk Flow, Exp-B, and SDR Flow+ Bulk Fill showed the lowest maximum stress rate.

## Financial interest Disclosure

Pulpdent Corp. donated some of the tested materials used in this study.