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BALANCING MELT FLOW AND MECHANICAL RESPONSE IN MINERAL-FILLED SIBS COMPOSITES

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Introduction

Poly(styrene-block-isobutylene-block-styrene) (SIBS) combines flexible polyisobutylene segments with polystyrene domains acting as physical junctions. This structure supports elastomeric behavior and thermoplastic processing, with established applications in demanding environments [1]. Mineral fillers can adjust hardness, density, and melt flow, but their effects on tensile performance depend on particle characteristics, dispersion, and polymer–filler interactions [2]. Studies of SIBS nanocomposites also show that increased strength can coexist with reduced extensibility [3].

The present study compares calcium carbonate ($CaCO_3$), barium sulfate ($BaSO_4$) and silica (SiO_2) in the same SIBS matrix. The objective is to distinguish the contributions of filler type and loading to the balance between melt flow, hardness, tensile strength, and elongation, supported by thermal analysis.

Materials and methods

$CaCO_3$ and $BaSO_4$ composites were evaluated at 5, 10 and 15 wt% filler against unfilled SIBS. SiO_2 was included at 5 wt% for comparison at equal filler mass fraction. Characterization comprised density, MFI at 190 °C, Shore A hardness, tensile strength and elongation at break. The three 5 wt% formulations were also compared by DSC using successive heating and cooling cycles over approximately 30–250 °C.

Mechanical values are presented as approximate values consistent with the reported graphical comparisons. Tensile strengths were converted from kgf/cm² to MPa using 1 kgf/cm² = 0.0980665 MPa. The results are interpreted descriptively; differences are not assigned statistical significance. Equal mass fractions do not imply equal volume fractions, so filler rankings include the effects of both particle properties and effective filler volume.

Results and conclusions

At 15 wt% $CaCO_3$, hardness increased from approximately 38 to 44 Shore A, while MFI decreased from approximately 7 to 4 g/10 min and tensile strength from 4.1 to 2.5 MPa. $BaSO_4$ maintained MFI near 9 g/10 min across the loading range and higher tensile strength than $CaCO_3$.

Table 1 - Comparison of SIBS composites at 5 wt% filler

Property	$CaCO_3$	$BaSO_4$	SiO_2
MFI (g/10 min)	6	9	6
Hardness (Shore A)	42	37	41
Tensile strength (MPa)	3.1	4.2	3.8
Elongation at break (%)	1200	1000	900–950

Values are approximate; MFI was measured at 190 °C.

At 5 wt% (Table 1), $CaCO_3$ retained the greatest extensibility despite lower tensile strength. $BaSO_4$ provided the highest melt flow and tensile strength among the filled samples, with strength close to unfilled SIBS. SiO_2 combined relatively high hardness with intermediate strength and the lowest elongation. Hardness alone therefore does not demonstrate tensile reinforcement.

DSC revealed differences between fillers during initial heating, followed by closer agreement between subsequent heating traces. This suggests contributions from processing history and physical relaxation during conditioning. The measurements do not establish a particular interfacial bonding mechanism.

These results support selecting fillers according to the required balance of flow, hardness, strength and extensibility. Microscopy and dynamic mechanical analysis would help distinguish the roles of dispersion, filler volume and interfacial effects in the observed responses.

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References

[1] Pinchuk, L.; et al. Medical applications of poly(styrene-block-isobutylene-block-styrene) ("SIBS"). *Biomaterials* 29 (2008), 448–460. https://doi.org/10.1016/j.biomaterials.2007.09.041.

[2] Bokobza, L. Elastomer Nanocomposites: Effect of Filler–Matrix and Filler–Filler Interactions. *Polymers* 15 (2023), 2900. https://doi.org/10.3390/polym15132900.

[3] Rezvova, M. A.; et al. Biocompatible Nanocomposites Based on Poly(styrene-block-isobutylene-block-styrene) and Carbon Nanotubes for Biomedical Application. *Polymers* 12 (2020), 2158. https://doi.org/10.3390/polym12092158.