# 45S5 in PCL: Mass Fraction and Interface

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**Abstract.** State whether 45S5 loading in PCL is expressed by mass or volume before comparing composites. This note provides the conversion basis and a development comparison that separates glass loading from dispersion, interface and processing effects.

**Keywords:** 45S5; PCL; mass fraction; volume fraction; interface

## 1. Calculate the volume occupied by filler

For a two-component, void-free composite, filler volume fraction is (w/filler density) divided by [(w/filler density) + ((1 − w)/polymer density)], where w is the filler mass fraction. Measured densities should replace assumed values when preparing a real formulation.

Illustrative calculation: assume glass density 2.70 g/cm³ and PCL density 1.145 g/cm³. A 30 wt% glass composite has volume fraction (0.30/2.70)/[(0.30/2.70)+(0.70/1.145)] = 0.154, or about 15.4 vol%. The density of the actual glass and any internal pores can change this estimate.

A melt-processed PCL study compared 30 wt% 45S5 with a calcium silicate filler [1]. It supports studying the processed interface, not assuming that the response of loose glass powder will be preserved after it is embedded in polymer.

## 2. Measure access to the glass

**2.1 Check where particles are located.** Examine surface and polished cross-section images. Distinguish embedded particles from particles exposed at the surface. A uniform bulk composition can coexist with a polymer-rich outer skin, so bulk loading alone does not define the initial contact between glass and medium.

**2.2 Track the processing burden.** Record torque or an available flow measure, residence time and temperature history. Compare properties only after checking dispersion and specimen void content. If changing the glass size also changes mixing energy, report both changes rather than assigning the result to size alone.

**2.3 Separate immersion outputs.** Use matched medium volume and geometry; record pH, dissolved elements, surface deposits and dry mass. Pair these with a polymer-sensitive measurement where degradation is the question. Mineral deposition can add mass while polymer or glass components are being lost.

## 3. Development decision

Choose loading and particle form together. Favor a reproducible exposed interface and stable processing over a high bulk glass percentage that cannot be dispersed or accessed consistently.

**Table 1.** Development comparison and interpretation controls.

| Proposed comparison | Hold constant | What it isolates |
|---|---|---|
| Neat PCL | Thermal history and geometry | Polymer baseline |
| PCL + glass | Nominal mass fraction | Combined filler effect |
| Two glass size bands | Glass chemistry and loading | Size and exposed-interface effect |
| Molded vs porous geometry | Formulation and conditioning | Architecture effect |

**Scope.** The 15.4 vol% value is an idealized conversion, not a measured porosity or a prediction of bioactivity. Confirm actual densities and final composite structure.

## References

1. Chouzouri G, Xanthos M. In vitro bioactivity and degradation of polycaprolactone composites containing silicate fillers. Acta Biomater. 2007;3(5):745-756. doi:10.1016/j.actbio.2007.01.005.

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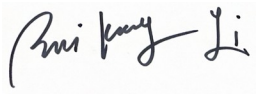

Reviewed by: Alex | Technical content: Approved

Review date: