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Supercritical-Assisted Design of SiO_2–TiO_2 Functionalized PLGA Scaffolds for Controlled Drug Delivery Applications

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INTRODUCTION & AIM

SiO_2–TiO_2 functionalized PLGA scaffolds are promising systems for controlled drug delivery and infection control. SiO_2 enhances drug encapsulation and sustained release through its porous structure, while TiO_2 provides antimicrobial activity via reactive oxygen species (ROS) generation, enabling localized and more effective therapies with reduced side effects.
These scaffolds are suitable for applications in wound healing, implant coatings, tissue engineering, and regenerative medicine.

Objective: Develop SiO_2–TiO_2 functionalized PLGA scaffolds using supercritical fluid technology and evaluate their potential as biocompatible platforms for controlled drug release and antimicrobial applications.

METHOD

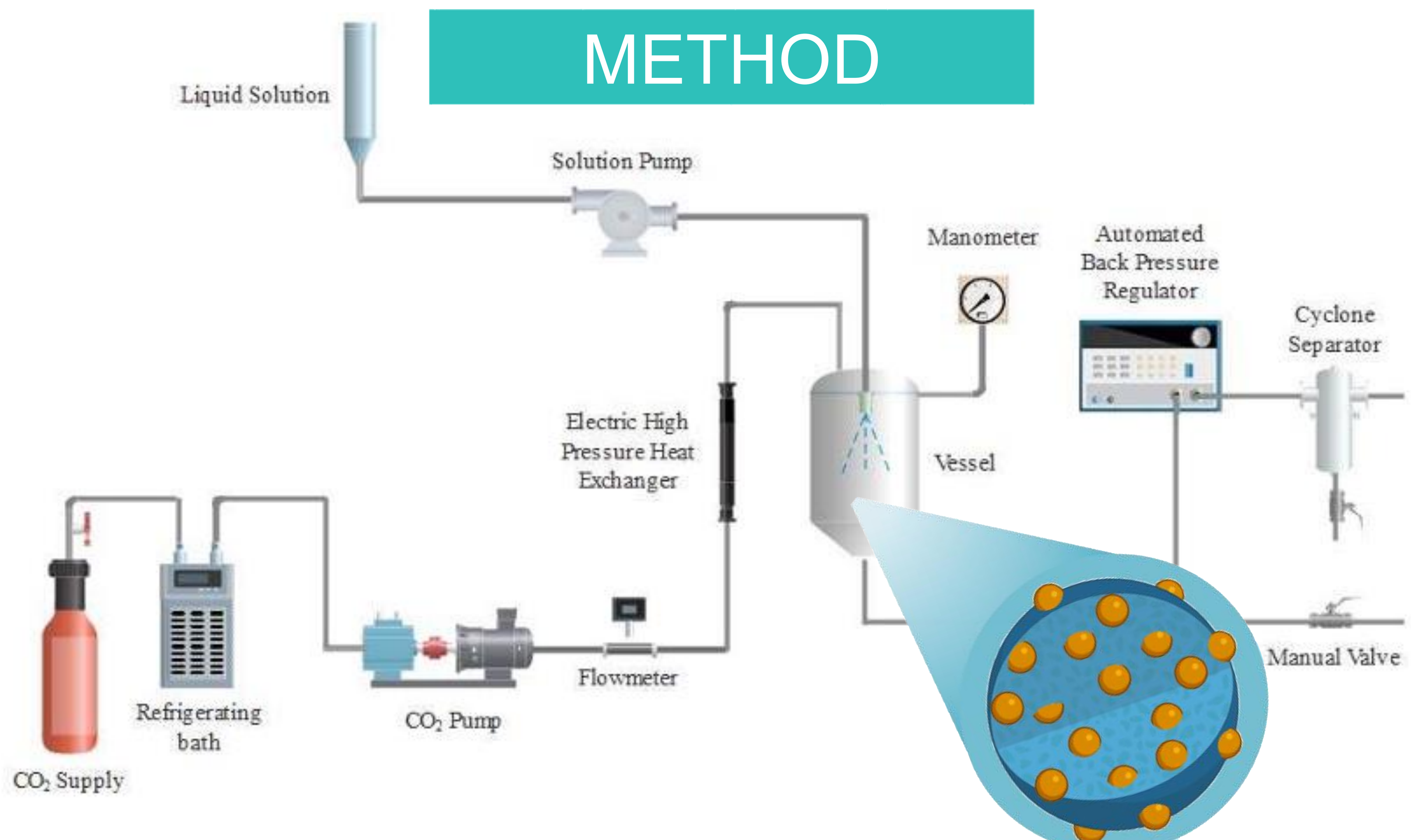


Figure 1. Supercritical Anti-Solvent (SAS) process

Table 1. Treatment conditions for the impregnation of silica and titanium oxide particles using the SAS process.

Pressure (bar)	Temperature (°C)	Flow rate (mL/min)
90	50	4
90	50	6
90	65	6
100	40	6
120	50	4
120	65	6
150	40	6
150	50	4
150	50	6
150	50	8
150	65	6

Table 2. Experimental design for PLGA impregnation into SiO_2–TiO_2 particles.

Pressure (bar)	Temperature (°C)
100	60
100	100
200	60
200	100
300	60
300	100

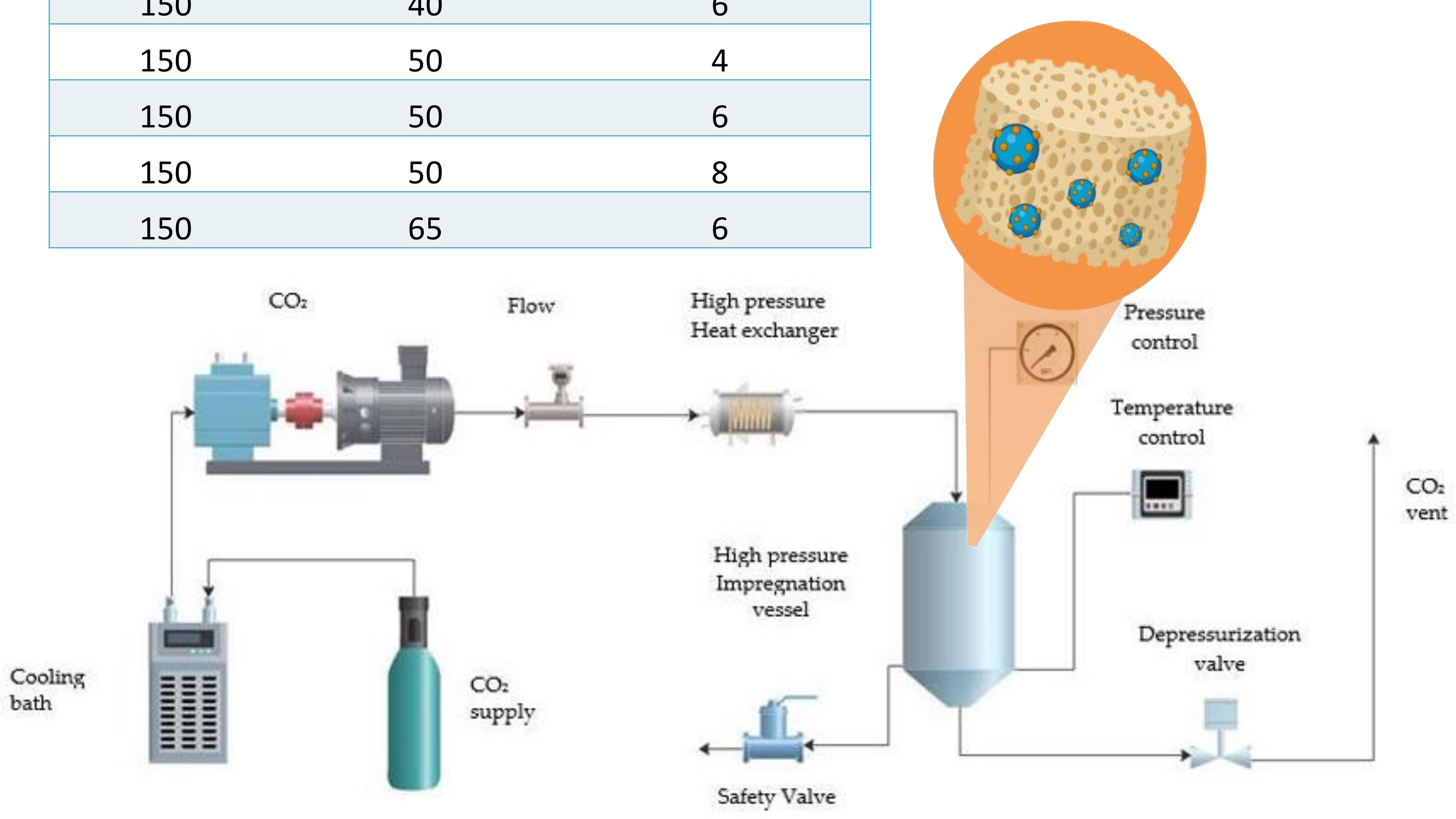


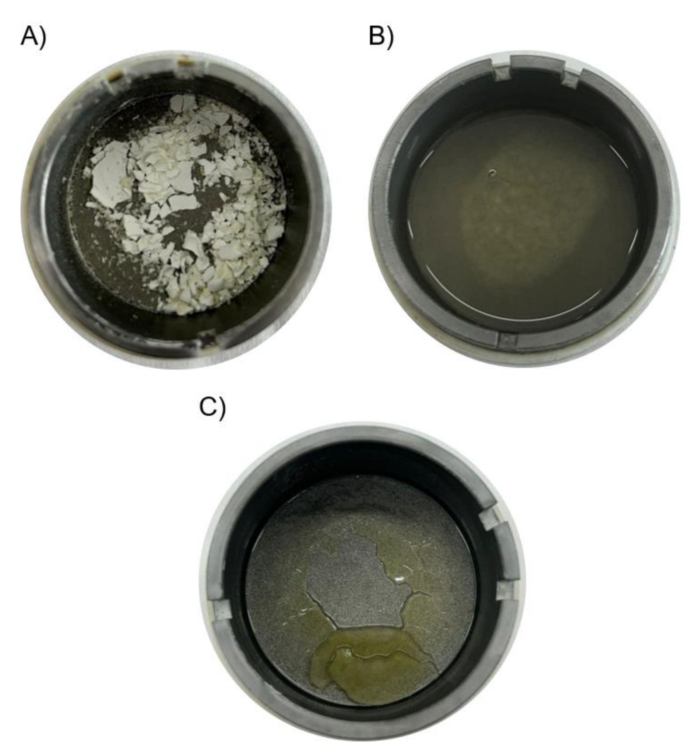
Figure 2. Diagram of the foaming/impregnation equipment setup.

CONCLUSIONS

- **SAS** process showed **strong dependence on temperature** and **CO_2 flow rate**, rather than pressure.
- Optimal conditions (**R2, R5, R9**) confirmed successful SiO_2–TiO_2 synthesis via EDX analysis.
- **Supercritical processing (300 bar, 100 °C) enabled homogeneous PLGA scaffolds** with uniform porosity, favoring controlled and sustained drug release.

RESULTS & DISCUSSION

Table 3. Recovery yield of silica and titanium oxide particles using the SAS process.



Testz	Pressure (bar)	Temperature (°C)	Injection flow rate (mL/min)	Condition	Weight (mg)	Yield (%)
R1	90	50	4	L		-
R2	90	50	6	S	54.4	2.8
R3	90	65	6	S	166.3	8.5
R4	100	40	6	L	20.2	1.0
R5	120	50	4	L	1.7	0.1
R6	120	50	6	S	3.5	0.2
R7	120	65	6	S	321.9	16.4
R8	150	40	6	L	-	-
R9	150	50	4	S	233.4	11.9
R10	150	50	6	L/S	-	-
R11	150	50	8	S	272.8	13.9
R12	150	65	6	S	321.9	16.4

Energy-dispersive X-ray spectroscopy (EDX)

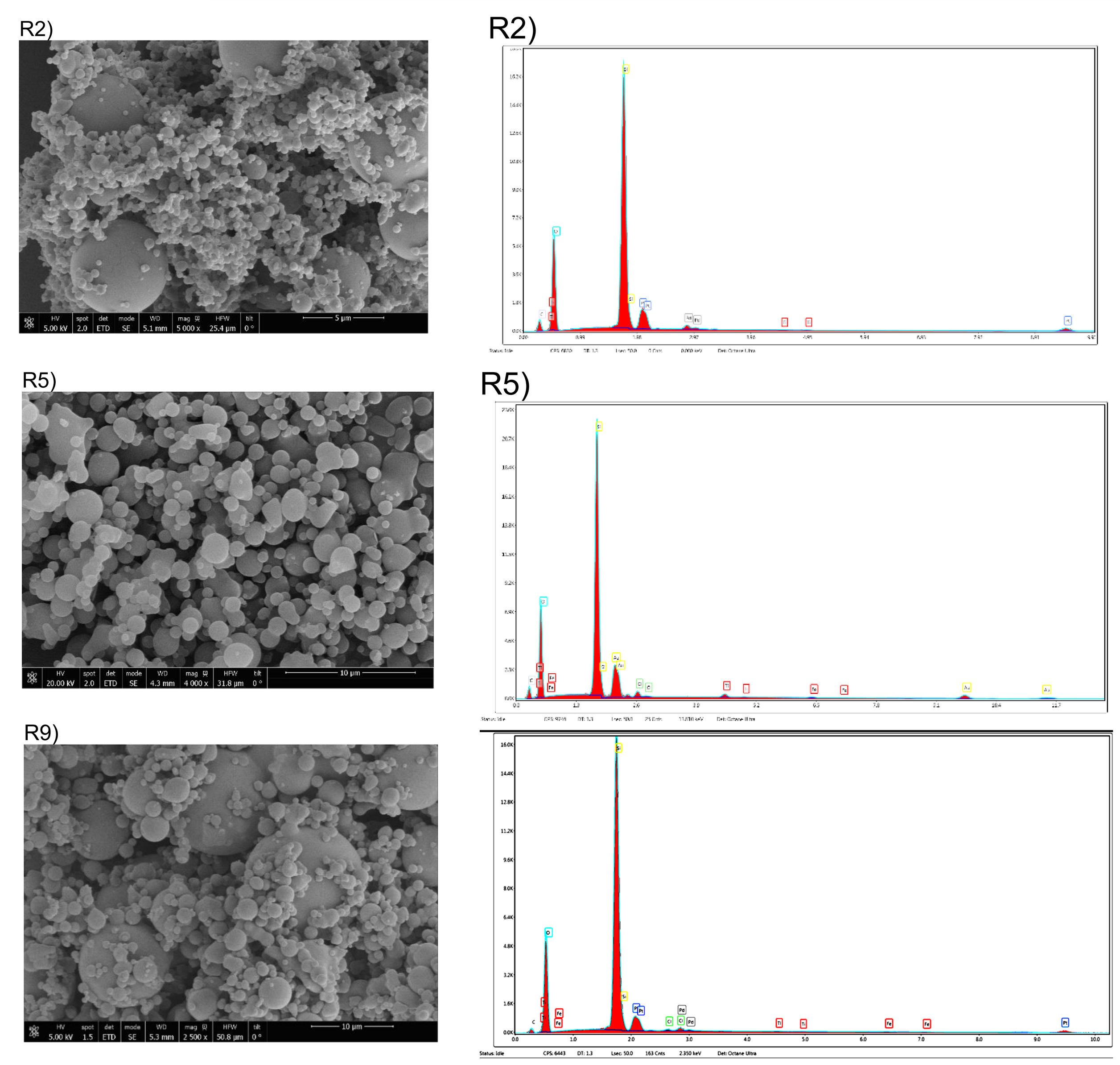
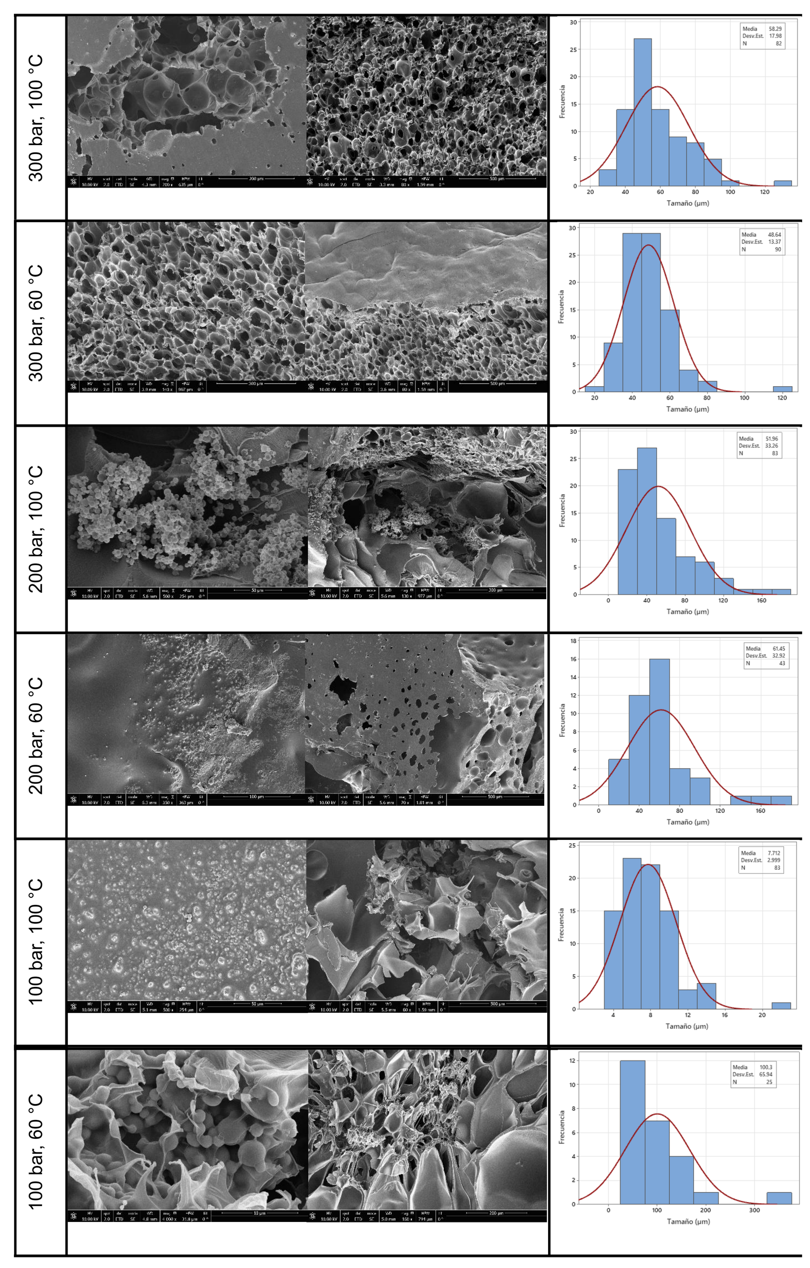


Table 4. Results of the experimental design for PLGA impregnation into SiO_2–TiO_2 particles.

Treatment	Foaming formation	Expansion factor (Vf/V0) Thickness	Expansion factor (Vf/V0) Diameter
Non-Treatment			
300 bar, 100 °C		0.202	1.034
300 bar, 60 °C		0.237	0.987
200 bar, 100 °C		0.223	0.978
200 bar, 60 °C		0.186	1.156



FUTURE WORK/ REFERENCES/ACKNOWLEDGMENT

- Adhesion and growth assays on foamed matrices for controlled drug delivery applications.
- Evaluation of antimicrobial activity.
- Assessment of controlled drug release from functionalized scaffolds.

References:
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