

Área: FIS

Obtenção de Materiais Compósitos a partir de Resíduos de Conchas e Resíduos de Poliestireno Expandido.

Alicia R. Canciani (TM)^{1*}, Dandara J. Anhaia (TM)³, Maria Flor M. Maia (TM)¹, Olga E. Cardoso (TM)¹, Vitória Regina P. Bazzanella (TM)¹, Claudia Lira (FM)².

aliciarcanciani@gmail.com

¹Curso Técnico em Química - DALTEC/IFSC; ²Departamento de Química IFSC; ³Curso Técnico em Saneamento - DACC/IFSC

Palavras Chave: *Reciclagem, Ostras, Carbonato de cálcio, Polímeros.*

Highlights

Production of Composite Materials from Shell Waste and Discarded Plastics. An alternative to marble and MDF, addressing improper shell waste disposal, ocean pollution, quarrying, and deforestation, while supporting environmental protection and the local economy.

Resumo/Abstract

Mariculture, the activity dedicated to cultivating marine organisms, plays a crucial role in the economy and culture of Santa Catarina, particularly in the Greater Florianópolis region, which is responsible for approximately 90% of oyster supply in Brazil (SECOM, 2023). However, the improper disposal of oyster shells significantly contributes to the degradation of coastal ecosystems, highlighting the need for sustainable practices such as reverse logistics to ensure the sector's sustainability. Additionally, plastic pollution represents a serious environmental issue for marine environments, affecting wildlife through ingestion and entanglement, while the breakdown of these plastics into microplastics further amplifies their harmful impacts.

In light of these challenges, there is an opportunity to develop innovative solutions through recycling and the creation of sustainable composites. Based on the chemical similarity between shells and rocks - both predominantly composed of calcium carbonate (CaCO_3) -, this work aims to provide a sustainable alternative for the construction industry by producing a composite material that uses ground oyster shells as a reinforcement in a recycled polymer matrix, promoting a circular economy and reducing environmental impact.

For the production of the composite board based on expanded polystyrene (EPS) - obtained from discarded polystyrene coolers and oyster shells - a proportion of 18 g of EPS per 4 mL of acetone was used to dissolve the polymer. Regarding the particulate material, two distinct particle size ranges were selected: a coarse fraction, consisting of particles that pass through a 1.7 mm mesh and are retained on a 600 μm mesh, and a thin fraction, comprising particles that pass through the 600 μm mesh.

To systematically define the optimal component proportions, a full factorial experimental design was employed, according to Ross (1995), considering two factors at three levels each. This design evaluated the mass proportions of EPS to shells at 70%/30%, 50%/50%, and 30%/70%, in conjunction with different proportions of thick to thin fractions. Test specimens with an approximate volume of 21.025 cm^3 were produced, thereby encompassing all possible combinations of the investigated variables.

Subsequent qualitative analysis of the surface and internal structure of the boards, with a focus on porosity, identified the most homogeneous formulation with the lowest incidence of voids. It was established that excessive porosity acts as stress concentration points, thereby compromising the material's structural integrity, as can be observed in Figure 1.

Figure 1. Microstructure of the composite with a proportion of 70% EPS and 30% shells by mass, demonstrating the low incidence of voids and structural homogeneity characteristic of the optimized formulation.



Source: Authors.

Furthermore, the technique for incorporating the solvent (acetone) into the EPS was found to directly influence the composite's final morphology. Specifically, more vigorous stirring promoted greater air entrapment within the mixture, which resulted in a significantly more porous material following the complete evaporation of the solvent.

Consequently, the formulation that exhibited the most favorable structural characteristics was the balanced proportion of 70% EPS and 30% shells by mass. Additionally, the optimal particle size distribution for the shell fraction was determined to be 70% thin particles and 30% thick particles. This specific combination facilitated efficient particle packing, wherein the finer particles filled the interstices between the coarse ones, ultimately yielding the most cohesive composite with the lowest porosity among all specimens tested.

For the test specimens, a higher density was observed for the granulometry of 70% thin particles. The density of CaCO_3 is 2.71 g/cm^3 , and the values found for these specimens (TABLE 1) are lower. This is due to the presence of EPS, which has a lower density compared to carbonate.

Table 1. Density of the specimen

composition	granulometry	density (g/cm^3)
30% shell	70% thin	0,7805
50% shell	70% thin	0,948
70% shell	70% thin	1,256

Source: Authors.

To conclude, the developed composite has the potential to satisfy some industrial demands like the MDF; this is because the density of EPS typically absorbs less than 3% by volume, even when submerged for long periods, while MDF has a high water absorption, in addition to deformation and swelling when exposed to water (ELEOTÉRIO, 2000). Since the best ratio found was 70% EPS and 30% shells, it is expected that the composites will have low absorption, like that of the matrix. Besides, this lower polymer density gives the material lightness, which makes it, for example, more practical and easier to transport, compared to other materials that contain CaCO_3 (such as marble). With advances in its formulation and manufacturing process, its physical and mechanical properties can be improved. Furthermore, it is possible to seek more sustainable alternatives to replace acetone in its production.

ELEOTÉRIO, Jackson Roberto. PROPRIEDADES FÍSICAS E MECÂNICAS DE PAINÉIS MDF DE DIFERENTES DENSIDADES E TEORES DE RESINA. 2000. 122 f. Dissertação (Mestrado) - Curso de Ciência e Tecnologia de Madeiras, Universidade de São Paulo, Piracicaba, 2000.

ROSS, Philip J.. Taguchi Techniques for Quality Engineering: Loss Function, Orthogonal Experiments, Parameter and Tolerance Design. 2. ed. New York: McGraw-Hill, 1995. 329 p. Disponível em: <<https://www.amazon.de/-/en/Philip-J-Ross/dp/0070539588#>>. Acesso em: 08 de out. de 2025.

SECOM (Santa Catarina). Secretaria Executiva da Aquicultura e Pesca. "Ostras de Floripa" podem entrar na lista de produtos catarinenses com selo de Indicação Geográfica. 2023. Disponível em: <<https://www.saq.sc.gov.br/ostras-de-floripa-podem-entrar-na-lista-de-produtos-catarinenses-com-selo-de-indicacao-g-eografica/>>. Acesso em: 08 out. 2025.

Agradecimentos/Acknowledgments

Our thanks to professor and advisor Claudia Lira for her constant support and guidance. We also acknowledge IFSC for providing infrastructure and resources, and CNPq for the research grant. Finally, we thank our team for their collaboration and dedication to creating sustainable materials and contributing to the improvement of our planet.