

Recyclable Polymer Systems in Craft Casting: A Critical Review with Practical Exploration of Ethylene-Vinyl Acetate (EVA)

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Abstract

The search for eco-friendly sustainable casting materials that are adaptable for cast practices has continued to gain attention. Most contemporary casting materials are not recyclable and pose environmental challenges. This paper is mostly a review paper that critically compares contemporary casting materials such as Plaster of Paris, Silicone, Resins to Ethylene Vinyl Acetate (EVA) with a view of drawing attention to the potentials of EVA as a recyclable and eco-friendly casting material as a way of suggesting a thermoplastic alternative to thermosetting casting materials. A practical approach was also adopted to showcase the mold casting potential of EVA and also demonstrate the use of EVA in craft production. The overall observations were recorded based on ease of handle, studio reflection, reusability cycle, and surface fidelity. The findings indicate EVA's potential as a recyclable casting material suited for casting and artwork production in Educational settings. The paper also explores the interdisciplinary discourse between Material Science, Ceramic practice and art education.

Keywords: Cast, Recycling, ceramics, Craft, EVA

1. Introduction

An overview of casting in craft and ceramic practice

Casting is an age old practice in ceramics forming, this technique allows craft makers and ceramists to reproduce intricate and complex design, shapes and art works with great precision. This process allows the replication of surface details and maintaining consistent thickness across replica of the same unit. This method involves pouring liquid clay into a mould where capillary action takes out the water leaving a solid clay on the surface of the mold.

Traditionally, plaster of Paris has been predominantly used owing to its low-cost easy handle and remarkable good drainage properties. According to Peterson (2000), for most conventional systems in both industrial and ware products, multi-piece plaster mold are chiefly employed to replicate complex forms despite the emergence of eco-friendly and digitally inclined processes.

Environmental Concerns and Practical Limitations of Conventional Casting Methods

The introduction of polymer based materials now rival the use of conventional casting materials such as composites, silicone and other porous polymer mold that offer more interesting varieties that offer flexible,

recyclable materials that are capable of being engineered more precisely (Callister & Rethwisch, 2018). Silicone and a number of other porous molds made from speciality polymer have allowed for pressure casting systems by allowing faster molding cycles, precision and offers the advantage of easy demolding of complex designs. The above mentioned has progressively reduced the over-dependence on conventional plaster of Paris as a material for prototyping and small scale casting works (Rice, 2000).

Statement of the Problem

Ceramics have become a household item that can be seen in every household. They have become part of our daily life as well as part of our cultural heritages. However, over the years there has been mounting environmental concerns due to its non-recyclability and the enormous amount of energy consumed during production. Polymers such as EVA have emerged recently to gradually replace the non-recyclable materials such as thermoplastics, ceramics and composites. This work looks into the potential of EVA as recyclable casting material with a view of replacing polymers such as Plaster of Paris in casting works.

Aim of the Paper

This paper is majorly a review paper that aims to bring to the fore the potential of EVA in alternative to conventional casting of materials due to its advantages, of low-cost, easy handle, and eco-friendliness. The paper also attempts to demonstrate practically the use EVA in craft production.

2. An Overview of Traditional Materials In Craft and Ceramics

Crafts and ceramics have continue to increase in demand worldwide, they are needed as consumer or household products. According to the American Association of ceramics, materials such as plaster of Paris (POP), Silicone Rubber, Latex Molds, and Resin Systems dominate craft and ceramic casting. These materials are discussed below:

Plaster of Paris is made from Calcium Sulphate Hemihydrate.

It is basically a fine powder that has gained popularity in casting and craft works largely due to its affordability, ease of use, and dimensional stability (Nawa & Badarulzaman, 2015). The major advantages of Plaster of

Paris in craft work stems from its low shrinkage, short curing time, relative light weight as well as its affordability. However, due to its light weight it is brittle and susceptible to water and wear after different cycle. These are major disadvantages especially when large scale industrial molds are in view.

Silicone Rubber

Owing to its flexibility, durability, and ability to replicate intricate surface details, silicone rubber has become widely used casting and ceramic work. It is widely used to create master mold from which many ceramics pieces can be reproduced (Su & Wu, 2010). Silicone rubber posses excellent chemical stability as well as good heat resistance, excellent shrinkage and flexibility. All these makes silicone rubber and excellent choice for mold casting. However, the disadvantage of silicone rubber stems from its relative less porosity and higher cost (Nawa & Badarulzaman, 2015).

Furthermore, it is not easily recycled; its uncured form constitute a hazard as it can be inhaled as vapor or dust. Hence, extra care must be taken when handling it for studio work (Rice, 2015).

Latex Mold

Either synthetic or natural, latex rubber has a long history as a casting material in ceramics and craft. This is due to advantages such as flexibility, low-cost, ability to show fine details. Latex rubber is generally suitable for small scale casts and cases where reuse is not of priority. Further on the advantages of latex include its ability to be applied in tiny coats, and comparative low-cost. However, it is relatively less durable to high frequency of tear, and degrading upon exposure to sunlight. (Nakaraningsih, 2017; Adjei, 2023) Latex mold can pose health hazard when not fully cured. However it is generally safe once cured. Allergies and skin irritation have also be reported (Adjei, 2015).

Also, since latex is only deployed for some one-cast systems, its leaves a considerable waste which is considered an environmental concern.

Polymers in Modern Craft Practices

The properties of polymers such as melting point, flexibility, and most importantly the

ability to be recycled plays a crucial role in how they are deployed by artist and craft makers. Plastics are generally classified as either thermoplastic or thermosetting polymers .

Thermoplastics are linear chained polymers that possess the ability to soften upon heating and solidifies upon cooling. This ability allows thermoplastics to be reshaped in diverse processes such as extrusion, and injection molding (Pachau, 2024). The ability to be remodeled multiple times makes thermoplastics the material of choice in crafts as it allows for the conservation of raw materials from virgin sources making it effective for experimental academic crafts.

On the other hand, thermosetting plastics are polymers that possess, permanent, heavily cross-linked 3-D polymer network. By contrast they cure into a permanent cross-linked structure upon application of heat. This makes it non recyclable, hence it cannot be melted once it is heated resulting to rigidity and heat resistance. They are the choice in large scale ceramic productions. Despite the popularity of thermosets in craft and ceramics work, there is growing environmental concerns due to their limited ability to be recycled.

Ethylene-vinyl Acetate (EVA) in Crafts

Ethylene-vinyl Acetate (EVA) is a copolymer of ethylene and Vinyl acetate. It is a thermoplastic with characteristics closely related to rubber as well as plastics. There is growing interest in EVA in material science and craft work due to its flexible and semi-crystalline nature (Wahab & Gund, 2024).

EVA is a major soft polymer with the ability to be turned tuned vice-versa from plastic-like to rubber like by varying the vinyl acetate content. This ability makes EVA a very adaptable polymer for craft and design works (Wahab & Gund, 2024).

Processability and Recyclability of Ethylene Vinyl Acetate

Owing to its thermoplastic nature, EVA is capable of being processed by methods such as extrusion, injection molding and casting. It is widely reported in literature to possess good processability and compatibility with fillers (reinforcing materials), dyes and pigments. This makes it suitable for low-scale

experimentation, academic craft and prototyping craft works (Wahab & Gund, 2024). However, limitations of EVA has been well documented majorly due to contamination during processing, this affects the recycleability of EVA especially when it is repeatedly heated in the presence of other additives such as adhesives. For this reason EVA is sometimes treated as a semi-disposable material.

Application of EVA in Footwear, Packaging and Crafts.

Due to its lightweight nature, EVA has been widely deployed in crafts, packaging and footwear production. In crafts, EVA has the ability to be thermo-formed, carved and laminated (Giri and Wan, 2016). In packaging, EVA comes in form of films where it is extruded in layers. Its clarity and flexibility makes it a good choice in packaging applications. For craft purposes, EVA has been partly used for educational models and costume making due to its easy handle flexibility, ability to be reshaped with ease.

3. Conceptual Framework: Circular Innovations in Craft.

This conceptual framework places craft within 3 contemporary discourses. It proposes that circular innovations in craft comes not only from technical changes in material as well as processing but via socio material, spatial and relational practices. This re-imagines how crafts are produced, remade and reused. Hence, this framework is framed around the following interlinked axes:

1. Circular Economy in materials science.
2. Sustainability Studio Practice
3. Interdisciplinary material transition.

These axes forms a platform in which to analyse and theorise collaborative craft network for material use as well as recycling.

1.Sustainable studio practice: the way studios manage their resources such as energy, raw material and labor all leads to circular innovation. The whole idea of sustainable studio practice involves the minimization of waste, modular design, shared tools and arrangements to reuse production wastes . In order to achieve this, craft practitioners make arrangements for shared storage, shared tools, maintenance, and material exchange. This idea

turns the sustainability approach into a network.

2. Circular Economy in Material Science: craft practices have been deployed to extend the life cycle, such practices include re-use of waste, repairs and refurbishing. These practices are what shapes circular innovation in crafts. Adapting circular innovation in craft

3. Interdisciplinary material transition: craft, ceramic and material science practices are increasingly becoming interdependent due to eco-friendly drive across both disciplines.

4. Practical Case Study: EVA in Craft Casting

Material Preparation: for the purpose of this work, modelling of mother mold was achieved using clay. Casting of the negative mold was achieved using silicon sealant braced with plaster of Paris. Then using EVA, the mother mold was replicated from the negative silicon mold housed with Plaster of Paris.

To produce the craft, the inner surface of the mold was lubricated using engine oil. EVA polymer was then heated using a hand heat vacuum pump and then placed on the surface of the mold. To couple the craft from multiple molds, EVA polymer was heated at the joint to seal the positive cast together. The craft was then left to cool at room temperature, where cooling was achieved in less than 30 minutes. Finally, the various parts of the multiple molds were split to unveil the craft made from EVA.



Figure: Craft from EVA



Figure 2: Craft from recycled EVA

Observations

Re-usability: Scraps of EVA and left overs were gathered and reheated using the hand vacuum. Upon softening, it was placed in another prepared mold to prepare another craft using the same process outlined above.

Surface Fidelity: The craft produced appeared slightly glossy, though crafts produced were not transparent, in terms of surface fidelity, the intricate parts of the mold was well replicated in the craft produced.

Studio Reflection: During craft production, normal safety precautions were observed. Gas mask as well as safety gloves were used. The polymer did not pose any threat to the handlers as no adverse reactions was noted.

Cost Efficiency: in terms of cost efficiency, the craft were produced easily. EVA being a relatively cheap with the added advantage of low heating time. The production of the craft was much more cost effective compared to epoxy and other resins.

Discussion

This chapter critically compares EVA with Plaster of Paris, Silicone, and Resin mold systems. This discussion will focus on comparing EVA with these contemporary cast forming materials under the following headings:

1. Sustainability
2. Accessibility
3. Adaptability
4. Educational Suitability

a.Sustainability: the above mentioned casting materials have different profiles in terms of origin, re-use, and potential end of life cycle impact on the environment. EVA is a

thermoplastic copolymer that is capable of being remelted and reprocessed. However, for most craft purpose EVA is usually filled or reinforced and used as a composite. This limits its recyclability (Magdalena, 2024) Recent research has seen EVA being reinforced with bio-fillers leading to a path where recycle and recovery is feasible (Rinkinen & Shove, 2023) Plaster of Paris by contrast is relatively inert and non-toxic in use. Once set, its is non-recyclable and gradually degrades with repeated use and exposure to water leading to the generation of mineral wastes. As for silicone molds, they are durable and infinitely reuseable. This gives it the advantage of low material turn over and increased life cycle efficiency. However, most casting silicone are petroleum based that are not readily recyclable, their production is also energy consuming since it involves energy intensive polymerization processes. For resin systems such as polyurethane and epoxy which are thermosetting polymers since they result in single cycle use and cannot be recycled or remelted. Also, resin systems require diluents and catalysts that are capable of generating harmful residues and hazardous emissions when not controlled. Though resins are known for high precision and low shrinkage, they are the least circular unless when being well managed. (Wortmann & Frese, 2022) Hence in craft practices where resource is a challenge, EVA and Plaster of Paris are moderate to low in terms of environmental burden. While while silicone and resin require higher risk in terms of material performance.

1. Accessibility: in terms of developing context, studios, cost and accessibility are of premium between these systems comparison. Where budget is limited and infrastructure limited, plaster of Paris inconsistently more accessible and affordable. It requires only water and containers for mixing . This quality makes it highly suitable for low budget community studio and local workshops.

In contrast EVA are becoming readily available, but it is comparatively more expensive than Plaster of Paris. Thermoforming EVA requires a heat source which can easily be adapted. It however represents a burden in terms of cost especially for low budget studio settings. Also in comparison, Silicone molds are more expensive as high-quality molds grades are

usually imported. Resins casting material are typically the most expensive options since it's supply is heavily dependent on international supply chains. Hence, it is limited to well funded studios or projects. (Wortmann & Frese, 2022).

It can be concluded that interns of accessibility, Plaster of Comes tops as the most cost friendly material, EVA is also a great option where heating tools and supply chain exists . For silicone and resin, they remain dependent on international supply an are mainly reserved for high performance projects.

b.Studio Adaptability

In comparison of how these materials can be integrated into diverse technical environments, EVA is more adaptable for sculpting, thermoforming and prototyping since it can easily be cured laminated or heat formed. Plaster of Paris in comparison is quiet messy to handle though it is also adaptable for casting work, mould production and carving. The downside of Plaster of Paris arises from spillage and dust from leftover. All these arise form poor management of studio and could be mitigated by instituting good studio management ethics. Furthermore silicone molds are more adaptable for complex works and multi-section systems. Silicone is also compatible with other materials and fillers in mold production. (Wortmann & Frese, 2022). Silicone mold however requires more expertise in it's formulation as they require accurate mixing ratio and curing conditions. For resin based systems, even though they offer better details and low shrinkage after cure, it's use requires sophistication and advance technology as it requires stable ventilation, protective laboratory wears and temperature control which are mostly not available in semi-formal or home studios.

In conclusion, EVA and plaster of Paris are the most adaptable where resources is a challenge to cast practitioners.

c.Educational Suitability

For educational use, ease of handle, safety, lower risk, and low-cost of equipment are all of great importance. Their suitability for educational purposes depends on how sites they are for introductory and simple educational practical demonstrations. For EVA, it requires heating tools meaning it can only be handled by advanced learners. It is

therefore more suitable for intermediate and advanced level educational purposes. Where there is access to basic equipment, plaster of Paris is however more suitable for educational purposes since it requires only simple mixing ratios and has a consistent curing behaviour. These makes it more suited for teaching how molds are created, casting, and general experimentation. Silicone molds are however more suited for advanced educational purposes it is highly adaptable for educational purposes since complex molds, multi-parts systems can be recreated with more ease.

For resins, they offer better surface fidelity, but with disadvantage of toxic fumes and chemical reactions. It is however risky to stage such a process in a poorly equipped unsupervised settings due to safety and ethical reasons. Hence resins are more suited for advanced studio educational practicals.

In summary, plaster of Paris is the most suitable educational purposes, EVA is of good potential for peculiar educational purposes, while silicone and resins are more adaptable for advanced educational purposes.

Implication for Craft Education and Sustainable Practices

Accessibility of material locally: plaster of Paris is in high demand in Nigeria this makes it highly accessible. It's also produced locally produced in Yobe State (Maiva *et.al.*,2025). This reduces the burden of dependence on imported materials EVA foam, silicone and resin in contrast are generally imported materials, it's supply can be limited in many rural and semi-urban centres in Nigeria. This in turn will limit the potential use in college and local studio.

Waste Reduction

Plaster of Paris and EVA presents less challenges in terms of hazardous waste when compared with resins and silicone systems. For studios in Nigeria where ventilation and equipment is limited in most studios (Maiva *et.al.*,2025). The recyclability and reusability of EVA makes it a good choice for further low-waste studies.

Potential for Adoption in Curriculum

Increasing scholarly work on recyclable materials for art and educational purposes demonstrates that renewable, reusable, materials increases the discussions in the

application to science and arts education to drive the shift toward practice based education curriculum in Nigeria and most West African countries (Akabueze *et.al.*, 2019). Integration of EVA and other materials casting techniques if based on renewability, reuse, recycling, low-cost, and circular design discussions has the potential to position Nigeria craft education as a focus for scholarly materials for educational purposes.

5. Conclusion

In conclusion, EVA showed a great potentials as a casting and crafting material as compared to other casting and crafting materials. EVA offered moderate sustainability potential and adaptability for prototyping and thermoforming simple crafts but remains cost and import constrained for low financed studio settings. The findings makes a good argument for EVA as an eco-friendly cast material for educational purposes where basic heating tools and moderate facilities exist.

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