

# Vacuum Cup Materials

UNDERSTANDING THE RIGHT COMPOUND FOR THE APPLICATION

By **Daniel Pascoe**, on behalf of Vacuforce LLC

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Figure 1

» **VACUUM CUPS ARE** available in a range of compounds, with each selected for specific application requirements. While many materials exist, four primary types are most used across industries.

This article explores these materials in detail, pertinent to their performance, advantages, and the best use cases for each.

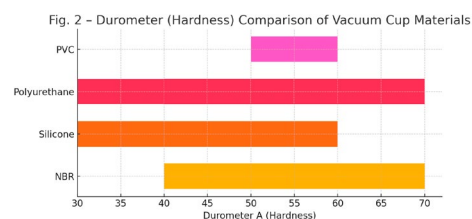


Figure 2

## THE IMPORTANCE OF MATERIAL HARDNESS

The starting point when selecting a vacuum cup material is typically its hardness, which determines its ability to form a reliable seal on a given surface. Hardness is measured using the Shore hardness scale, often referred to as the durometer scale (Fig. 1 shows a durometer hardness tester). It is named after its inventor, Albert Shore. The Durometer A scale (shown in Fig. 2) used for rubber-based materials ranges from 5 (very soft) to 100 (very hard). Most vacuum cups fall between 35 and 70 durometer A. Understanding this value is

key to ensuring that the cup seals effectively on surfaces ranging from smooth metals to rough cardboard.

## TEMPERATURE RESISTANCE: A CRITICAL SELECTION FACTOR

Beyond hardness, temperature resistance plays a significant role in material selection. While most applications occur at ambient temperatures, some, such as plastic injection molding or frozen food packaging, require materials that can withstand extreme heat or cold.

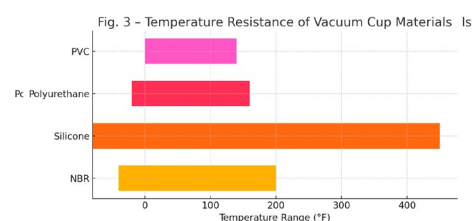


Figure 3

Vacuum cup compounds typically perform within a range of -40°C to 204°C (-40°F to 400°F). Refer to Fig. 3. However, it's essential to assess the actual temperature of the product being handled and not just the environment or mold. Overestimating temperature needs by adding unnecessary safety margins can lead to inflated costs. For example, a molded part leaving a 93°C (200°F) mold may cool rapidly, making it safe for handling with a material rated below that threshold, especially if contact is brief. Keep in mind that a vacuum reduces air molecule density, which can lower surface temperatures further during handling.

## MATERIALS

### NBR (NITRILE RUBBER)

NBR, also known as Buna-N, is the most widely used vacuum cup material. It's highly resistant to oils, greases, and industrial chemicals, making it ideal for general-purpose applications such as metal, plastic, wood, and cardboard handling. NBR is typically 60 durometers but can range from 40 to 70 depending on the manufacturer.

NBR is often overlooked for high-heat applications due to the assumption that only silicone will suffice. However, many plastic injection parts can be safely handled with NBR if the part temperature remains within the material's capability (around 93°C (200°F)). It provides superior abrasion resistance compared to silicone, making it a cost-effective and durable choice in many scenarios.

### SILICONE

Silicone vacuum cups offer exceptional temperature resistance, handling both extremely cold and hot environments up to 230°C (450°F). This makes them suitable for use in frozen food packaging and hot molded plastic applications. Silicone is softer than NBR, allowing better sealing on contoured, uneven, or porous surfaces such as corrugated plastic or cardboard. Additionally, FDA-compliant silicone (FDA 21 CFR 177.2600) defines which rubber articles, including silicone, are safe for repeated contact with food. This is available for applications involving direct contact with food

or pharmaceuticals, ensuring there is no contamination from dyes or additives.

Metal-detectable silicone is widely used in food processing environments as an added safety measure to protect both consumers and manufacturers. In high-speed production lines handling baked goods, packaged foods, or pharmaceuticals, there is a risk that a partial or full vacuum cup may become dislodged and fall into the product stream.

By incorporating metal-detectable additives, e.g., iron dust, into the silicone compound, these cups can be easily detected by inline metal detection systems that are standard in most food manufacturing facilities. This allows for immediate identification and removal of any contaminated batches before packaging or distribution.

The benefit of this safety feature cannot be overstated. Foreign object contamination is one of the leading causes of damaged brand reputation and consumer injury. A single undetected vacuum cup fragment could trigger a costly full-scale recall, halting production and distribution while exposing the manufacturer to liability and regulatory scrutiny.

By using metal-detectable silicone, manufacturers demonstrate a proactive commitment to food safety and quality control. This significantly reduces the risk of recalls and complies with Hazard Analysis Critical Control Point (HACCP) and other global food safety standards. Note: Silicone should never be used on surfaces intended to be painted, e.g., automotive body panels. Contact with silicone can cause paint bonding issues known as fisheyes. As a result, many automotive plants prohibit its use entirely.

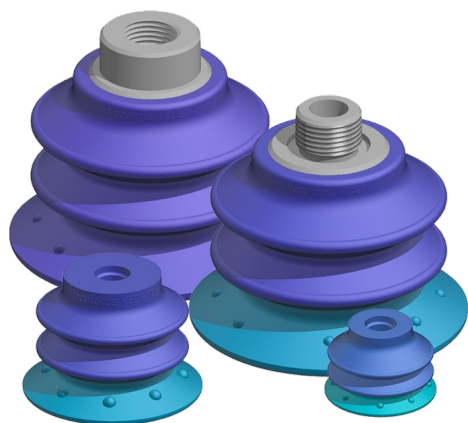


Figure 4

## POLYURETHANE

Polyurethane offers solid wear resistance, outperforming both NBR and silicone in abrasive applications. It's especially useful for high-speed or long-cycle production lines where cup longevity is critical. However, polyurethane generally offers a narrower temperature range, and its cost is higher than that of NBR. Some vacuum cup designs use a dual-durometer configuration (Fig. 4), a soft sealing lip combined with a rigid core. This balances seal flexibility with structural stability. With that being said, these dual-compound cups are labor-intensive to manufacture, which adds to their cost.

## PVC (VINYL)


PVC vacuum cups offer a low-cost alternative with trade-offs. While they are highly resistant to abrasion, the mechanical properties of PVC are inferior to rubber-based materials. They are prone to hardening and cracking, especially in dynamic stress areas such as bellows corners. Their limited temperature range and durometer options further restrict their versatility. Though initially inexpensive, PVC cups may have higher long-term costs due to more frequent replacements. They serve as a low-cost solution for simple pick-and-place applications.

## COLOR AND MATERIAL IDENTIFICATION

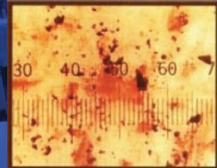
Color alone cannot reliably indicate the cup compound. For example, NBR is usually black, silicone is often red or white, polyurethane comes in a variety of colors, and PVC is generally clear or lightly colored. To select the correct vacuum cup, start with the application, not the appearance. Consider the following: Does this application truly require silicone? Could a more economical compound like NBR be equally or more effective?

## CONCLUSION

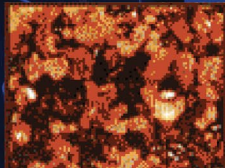
Choosing the right vacuum cup material depends on a solid understanding of the application, including surface type, temperature, wear conditions, and regulatory requirements. Assuming the existing material used in an application is correct isn't ideal. It's always worth reassessing if a better-performing or more cost-effective option is available.



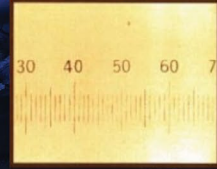
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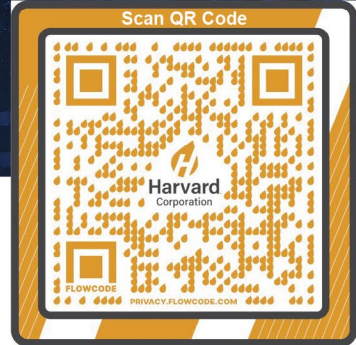
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