FactFile

Aquasil® Ultra+

Smart Wetting® Impression Material

Aquasil® Ultra+ is the next generation of the well-established Aquasil® line of vinyl polysiloxane (VPS) impression materials featuring several options for viscosity (xtra-low, low, medium, heavy, and rigid) and setting time (fast and regular). With all these varieties, it is indicated for use for all dental impression techniques. Via Dentsply Sirona's proprietary quadra-functional modified (QM) resin and Smart Wetting® technologies **Aquasil® Ultra+** provides high tear strength as well as excellent hydrophilicity and detail reproduction.

Tear Strength

Impression materials must be strong at the time of removal from the patient's mouth to resist tearing. A high tear strength of the material is of particular importance in thin areas such as the preparation margin and interproximal spaces. A recent study compared the tear strength of various low-viscosity, fast-set impression materials at 120-µm thickness using a standard tensile method. **Aquasil® Ultra+** was significantly stronger than the other impression materials tested at both the manufacturer's recommended mouth removal time and after 24 hours of setting (Figure 1).

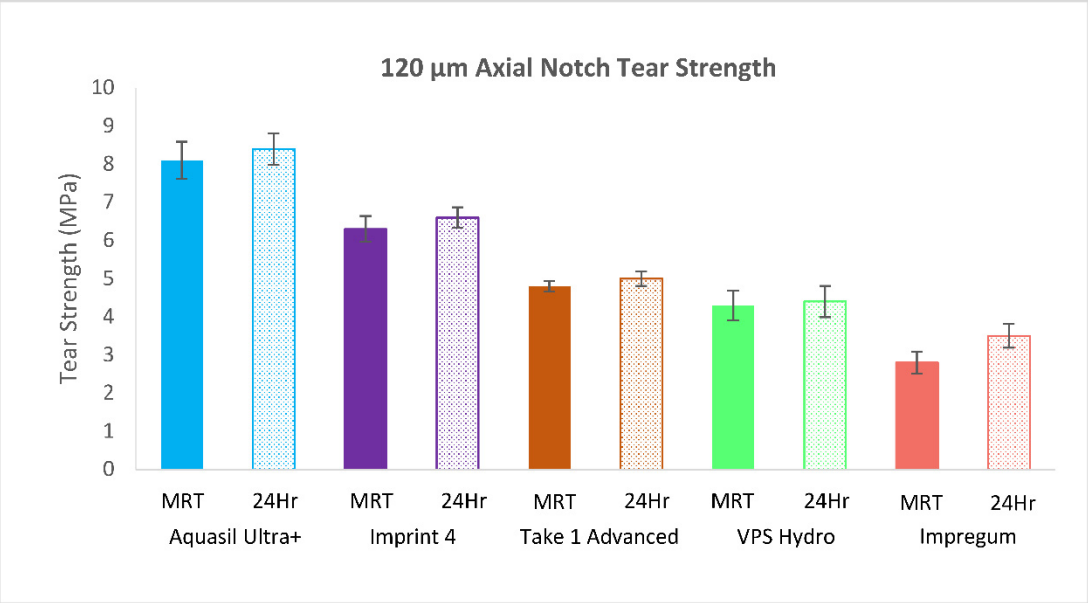

Fig. 1 Tear strength of different impression materials at mouth removal time (MRT) and after 24 hours of storage (Boghosian AA & Monaghan P, 2017).

Dentsply Sirona

Research

Driving the superior tear strength performance of **Aquasil® Ultra+** is Dentsply Sirona's QM-resin technology. First, compared to regular VPS resin which is bi-functional, QM-resin is a quadra-functional short-chain VPS oligomer. Because of this quadruple functionality, the crosslinking density of the polymer is much higher when compared to traditional addition silicone VPS (A-silicone) materials even though they share the same polymerization mechanism (Figure 2).

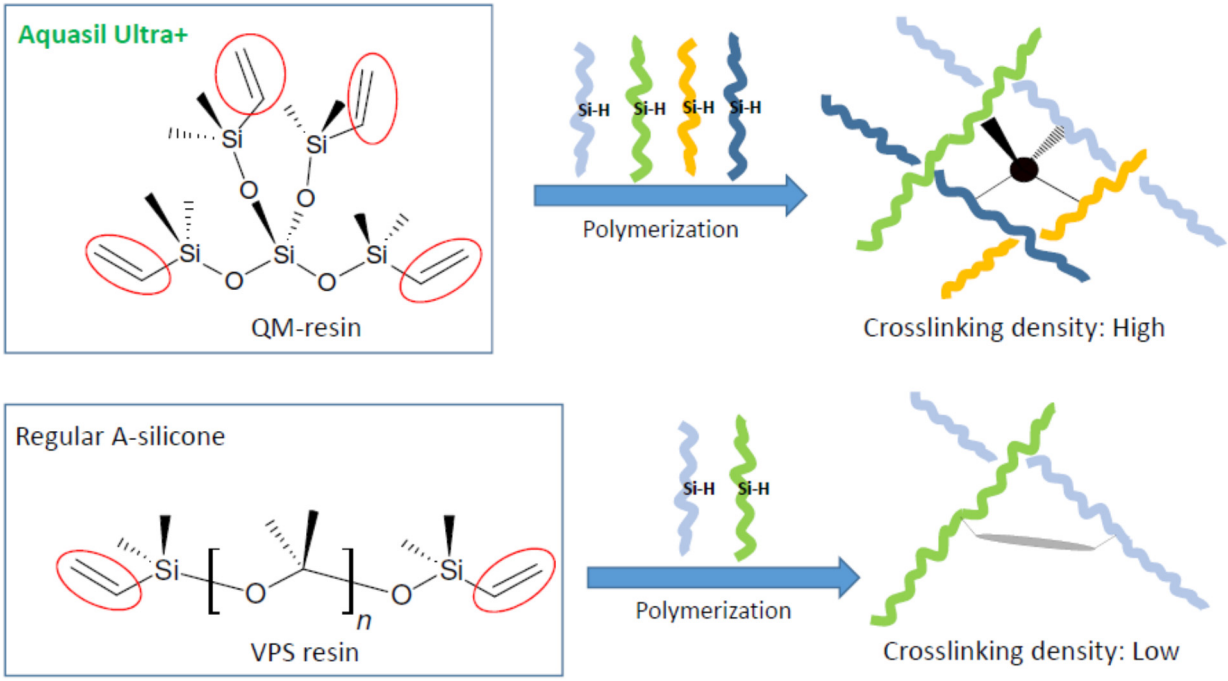

Fig. 2 Each QM-resin molecule has four vinyl functional groups (red circle), which can react with four silicone hydride (Si-H) groups. Traditional VPS molecules have only two vinyl functional groups.

Second, the short-chain nature of the QM-resin renders **Aquasil® Ultra+** a unique multi-modal system. While unimodal systems have polymer chains following a normal distribution in chain length, a multi-modal system is formed when very short chains (such as QM-resin) are added to normally-distributed long-chain resins (such as regular VPS). Polymers of unimodal systems are either too brittle (short-chain unimodal) or too soft (long-chain unimodal), both resulting in a low rupture energy. In contrast, a multi-modal system with well-designed short/long chain ratio has each chain segment playing its respective role in the event of elongation. The soft long chains stretch first, providing flexibility to the polymer matrix. As the deformation continues, the short chains follow, and afford increased strength due to their rigid structure (Figure 3).

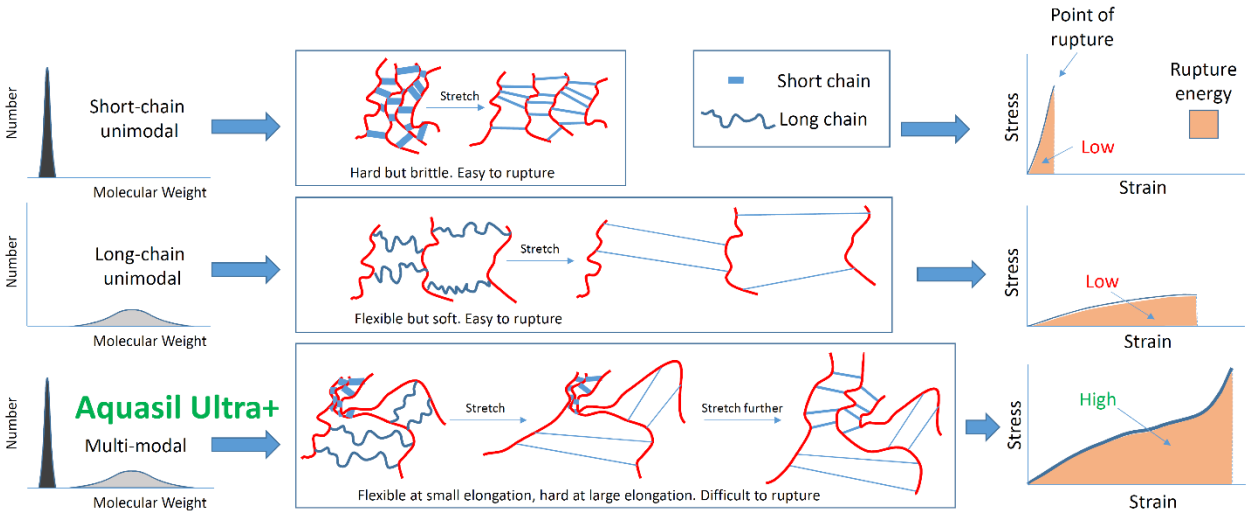

Fig. 3 The difference between unimodal and multi-modal systems in molecular weight distribution, in the event of elongation, and the resultant rupture energy.

Hydrophilicity

In addition to tear strength, hydrophilicity is another key metric for impression taking. In an uncured state, an impression material with good hydrophilicity reduces the risk of voids at or near the preparation margin by swiftly spreading onto the moist hard and soft tissues. Equally importantly, in the cured state, good hydrophilicity helps deliver accuracy at the dental lab when stone models are poured. To demonstrate hydrophilic behavior, contact angles made by a water droplet on both the uncured and cured surface of low-viscosity, fast-set impression materials were measured. A material with a lower contact angle is more wettable and hydrophilic. When tested on uncured **Aquasil® Ultra+** in a high-humidity environment, the contact angle reached 15° in 2 seconds. This is indicative of a fast spreading in the presence of natural hydration, so overdrying of the prepared tooth is not necessary. Similarly, when contact angles were compared on cured impression materials, **Aquasil® Ultra+** also exhibited outstanding hydrophilicity (Figure 4).

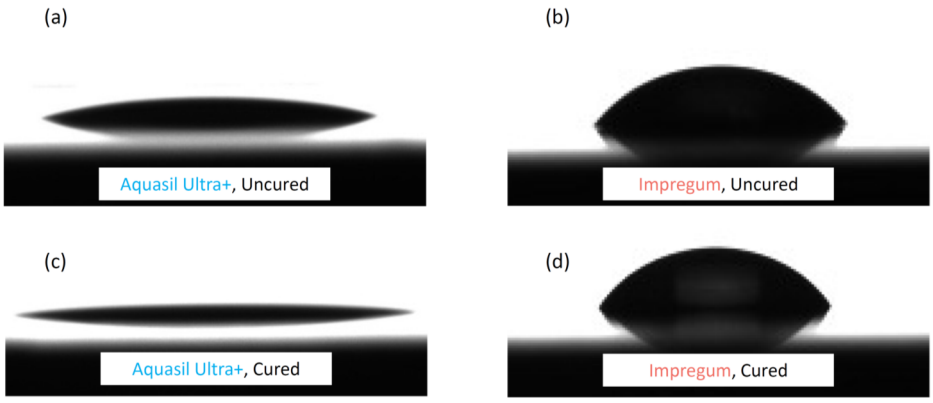

Fig. 4 Different contact angles between two impression materials on uncured surface after 2 seconds at 80% RH (a, b) and cured surface after 5 seconds at 50% RH (c, d). RH = relative humidity (R&D Dentsply Sirona, 2016).

The high hydrophilicity of **Aquasil® Ultra+** is obtained by Dentsply Sirona's Smart Wetting® technology. Smart Wetting® employs a proprietary blend of surfactants carefully engineered with regard to chemical structures of a hydrophobic head and hydrophilic tail, hydrophilic-lipophilic balance value, as well as degree of fluorination. Synergistically, the surfactants grant the hydrophilicity of **Aquasil® Ultra+** unsurpassed by other impression materials, either A-silicone or polyether based, regardless of cured or uncured state (Table 1).

Table 1 Mean contact angles on uncured (after 2 seconds at 80% RH) and cured (after 5 seconds at 50% RH) impression materials. RH = relative humidity (R&D Dentsply Sirona, 2016).

	Uncured material contact angle	Cured material contact angle
Aquasil Ultra+	15°	5°
Imprint 4	19°	6°
Take 1 Advanced	72°	88°
Impregum	49°	54°
Flexitime	55°	58°
Exafast NDS	68°	66°

Detail Reproduction

With Smart Wetting® technology, **Aquasil® Ultra+** is able to form intimate contact to moist surfaces. As a result, it captures minute details of teeth and gingival tissues, which makes certain of a proper fit for the final restoration. For the purpose of illustration, shown in Figure 5 is an impression taken of a US penny using **Aquasil® Ultra+** low-viscosity (LV).

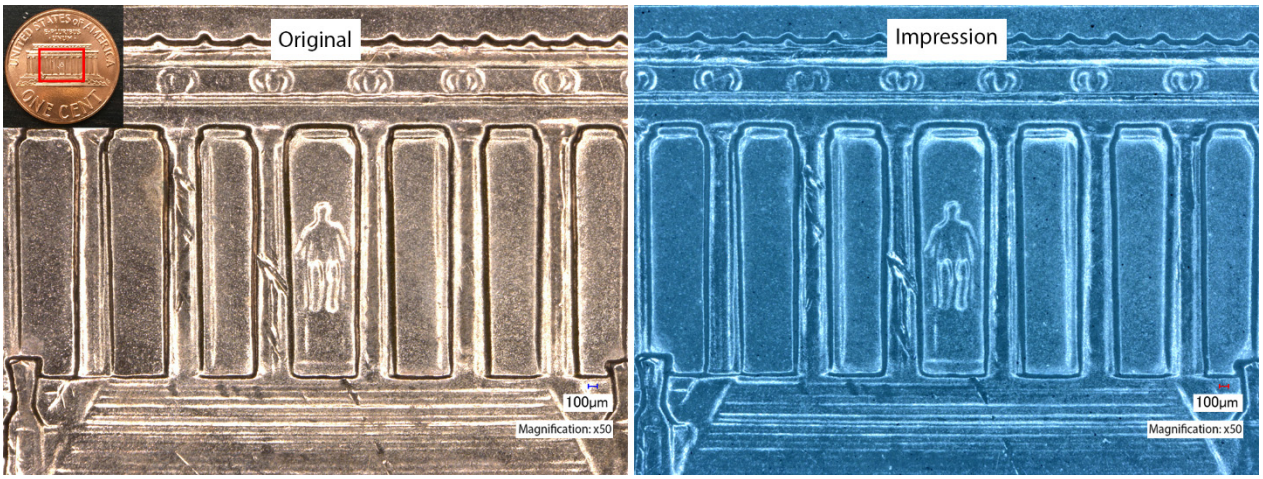

Fig. 5 The iconic Lincoln statue on the back of a US penny, hardly visible to the naked eye (left). Impression taken with Aquasil® Ultra+ LV reproduced its details with precision (right).

Clinical Evaluation

A total of 328 existing Aquasil® Ultra users evaluated the handling properties of **Aquasil® Ultra+** under the condition of daily practice. More than 95% of the users found that the impression material "meets" or "exceeds" their expectations. Important aspects of the material were its good flowability into details of the preparation, an optimized thixotropic behavior, and the importance of an ideal set-time. The accuracy of impressions obtained with **Aquasil® Ultra+** has been investigated in another clinical trial. Ten crowns were placed in a minimum of eight patients at five different testing sites. Randomly assigned, 50 impressions were either taken first with **Aquasil® Ultra+** or with its predecessor as control, followed by an impression with the remaining material. All the impressions were inspected for detail reproduction and defects such as voids or tears. Finally, ceramic crowns were fabricated from impressions made with **Aquasil® Ultra+** and evaluated by the dentists for accuracy of fit during the try-in. All the impressions taken were generally acceptable and there have been no remakes reported. More than 90% of the crowns needed only minor to moderate adjustments to achieve a proper fit.