Introduction

Since the launch of Revlon ColorStay in earlier 90’s, the long wear transfer-resistant color cosmetics have moved from niche to mainstream, from just a few lines to whole range products, and has since transitioned from a mass market into more premier brands. Long wear transfer resistant makeup has enjoyed fast-growing category and become consumer’s beloved product lines in the last several decades.

Recent advancement in the development of transfer-resistant color cosmetics has transformed the perception of these products from drying and cemented feel and look to more moisturizing and soft texture much closer the regular makeup. Polymeric film formers, such as silicone MQ resin, in the presence of non-volatile oil played an important role in the development of long wear transfer-resistant color cosmetics [1-3]. The introduction of thermoplastic elastomers in MQ resin formulation has resulted in great improvement of transfer-resistant makeup and brought a step closer to the feel and look of regular makeup [4-5].

Review and discussions

An ideal polymeric film former for transfer-resistant color cosmetic formulation would have possess good “breathable” film forming property, good binding power for pigments and fillers, as well as good adhesion to skin. The rigidity of the film can be manipulated with addition of non-volatile oil as plasticizers during the formulation to adjust the softness of the film. The compatibility of the film former and plasticizers is crucial and will affect the overall performance of makeup.

Extensive studies in the past has demonstrated that silicone MQ resin is the one of the best film formers in formulating transfer-resistant makeup comparing with other linear or graft polymeric film formers. MQ resin is a spherical silicone polymer consists of a core of three-dimensional Q units (SiO$_{3/2}$) surrounded by a shell of M units (Me$_2$SiO) with some residual silanol functionality on the surface. MQ resin is used extensively in the silicone pressure sensitive adhesive (PSA) formulation known as a “tackifier” for a gum of dimethyl or dimethyl-diphenyl silicone-based polymer in the presence of coupling agent. By adopting similar approach without chemical crosslink, a transfer-resistant cosmetic composition can be delivered with a simple mixture of MQ resin and non-volatile oil as shown in figure 1. Typical transfer-resistant color cosmetic compositions may comprise MQ resin, compatible non-volatile oil, volatile solvents either hydrocarbon or silicone based, pigments and fillers. The performance of transfer-resistant cosmetics is a balance that is mainly controlled by the ratio of MQ resin to non-volatile oil.

The above technical approach provides foundation for the first generation of transfer-resistant color cosmetic products and has limited transfer-resistant cosmetic products to either providing high tack with good skin adhesion or low tack with poor skin adhesion. MQ resin is often referred as a film former and non-volatile oil is often referred as a plasticizer for MQ resin in cosmetic formulation. In this “film former” plus “plasticizer” model, it is understandable that the composition comprises a mixture of a solid MQ resin with compatible oil as a plasticizer is suitable for transfer-resistant color cosmetic applications.

Figure 1. Schematic representation of MQ resin and a non-volatile oil mixture

Thermoplastic elastomers are a class of...
block copolymers consisting of hard and soft block segments with separated domains. The hard segment acts as a physical crosslinking bond and behaviors like plastic materials, while the soft segment is in rubbery state with elastic property. The most recent advancement in formulating transfer-resistant cosmetics has developed with the use of thermoplastic elastomers to replace non-volatile oil in mixing with MQ resin or other solid “tackifier” resins. Due to the close much in compatibility in designed materials, MQ resin will preferably stay in the elastomer domain and interacts with soft segment of the block copolymer as shown in figure 2. The soft segment of block copolymer acts a plasticizer to interact with MQ resin similar to the oil and MQ resin mixture as shown in figure 1. This results in a new class of transfer-resistant formulation with improved physical properties and product performance.

It is inconceivable in conventional wisdom that the mixture of a solid resin with a solid polymeric material results in the formation of a softer material with good adhesion and less tack on skin. The fact that the mixing of two solid materials results in a transfer-resistant color cosmetic product implies the importance for understanding supramolecular interactions between inter-molecular chains. The supramolecular Chemistry is the chemistry of molecular interactions or assemblies using non-covalent bonds which provides approach to Nano scale systems with applications ranging from biology to materials science. Non-covalent bonds between inter-molecular interactions can vary in type and strength, ranging from very weak dipole-dipole interactions to very strong metal-ligand or ion-ion interactions. The non-covalent inter-molecular interactions, rather than chemical bonds, play a critical role in tailoring the physical property and performance of resulting transfer-resistant cosmetic products. Solubility parameters and specific inter-molecular interactions, such as hydrogen bonding interactions, are among the most important consideration in designing and formulating such transfer-resistant color cosmetics.

**Future Developments**

Although, the cosmetic industrial has achieved several major milestones in pursuing long wear transfer-resistant color cosmetics in the past decades, there are still major consumer need gaps and challenges for the delivery of long wear transfer-resistant color cosmetics with a better overall performance and comfort. Some of these attributes may in fact contradict to each other and hard to deliver with traditional formulation technology. A multi-discipline approach for a better understanding of fundamental science from molecular level among various raw materials in the formulations will provide chemist with valuable inside in developing new raw materials and formulations.

**References**