doi:10.1017/S1431927610055595
Microsc. Microanal. 16 (Suppl 2), 2010

Characterization of Substrate-Active Ingredient Interactions using in-situ Microscopy

G. A. Camacho-Bragado* and F. M. Dixon*

* L`Oréal Recherche, Institute for Ethnic Hair and Skin Research, Chicago, IL.

Development of products for cutaneous application; including personal care, cosmetic and pharmaceutical products, requires a detailed understanding of the properties of ingredients as well as their interaction with the substrate (i.e. the stratum corneum). Besides the main active ingredient, topical products contain a wide variety of compounds that regulate the delivery of the active or act as lubricants, binders, diluents, drying agents or fillers. These ingredients may have an impact on the behavior of the product or may influence processing conditions. The morphology of the stratum corneum and its low permeability regulates aspects of a topical product such as substrate coverage, drying rate and durability. Additionally, the behavior of such a product on the skin is continuously modified by metabolic processes such as sweating and body temperature fluctuations. A detailed analysis of the effect of some of these dynamic processes on the evolution of the product deposit can help to tailor the final formula to obtain a particular cosmetic or therapeutic effect (drug release rate, appearance or feel of the film).

Electron microscopy techniques and particularly low-vacuum/environmental scanning electron microscopy (LV-SEM/ESEM) are widely used by the pharmaceutical and personal care/cosmetic industries to solve quality control, contamination and processing related issues [1-4]. Furthermore, the use of these techniques in the research and development phases has been increased [5-7]. Based on the information obtained by ESEM and conventional SEM, formulae can be optimized to avoid potential processing problems such as sticking-picking [1] or to provide a desired behavior such as a controlled release of an active ingredient [8]. In ESEM, multiple thermodynamic states can be reached by carefully controlling sample temperature and chamber pressure [9, 10], expanding the capabilities of ESEM beyond the analysis of insulating or hydrated samples with minimal sample preparation into the realization of multiple dynamic experiments as well as *in-situ* testing of such materials.

In this study, a series of ESEM experiments were designed to characterize two commonly used excipients/drying agents, in contact with water and with sweat. Film formation processes on stratum corneum and hair were also studied and compared to studies performed on inorganic substrates. The experiments were performed on an FEI Quanta 400 FEG ESEM equipped with a GSED detector. Hydration-dehydration studies of a hydrophobic and a hydrophilic excipient were completed in the presence of water (*in-situ* condensation) and in the presence of sweat that was administered using a Kleindiek microinjector. The drying rate and mechanism for the excipients were characterized. The presence of ionic compounds, such as those contained in sweat, modified the drying rate as well as the end morphology of the agents.
Drying of a film-forming aqueous dispersion on different substrates was followed *in-situ*. Figure 1 shows different surface morphologies obtained when a film former compound is dried on the surface of a standard microscope holder compared to the same compound applied to human stratum corneum. These images highlight the importance of studying the product-substrate interfaces using the actual biological substrate.

References

[1] J. P. Neilly, et al., *Microsc. Microanal.* 15 (Suppl 2) (2009) 18
[2] E. F. Schumacher, *Microsc. Microanal*. 12 (Suppl 2) (2006) 198CD
[3] P. C. Schmidt, *Secondary Electron Microscopy in Pharmaceutical Technology*, Marcel Dekker, (2002)
[4] P. R. Toepfer, et al., *Microsc. Microanal*. 12(Supp 2) (2006) 1646 CD
[5] Z. Barkay, et al., *Micron* 40 (2009) 480
[6] S. Hatziantoniou, et al., *Micron* 38 (2007) 819
[7] B. L. Bustard, et al., *Microsc. Microanal* 12(Supp 2) (2006) 1642 CD
[8] A. Pawar, et al., *AAPS Pharm. Sci. Tech* 5 (2004) 1
[9] J. M. Manero, et al., *Microscopy Research and Techique* 61 (2003) 469
[10] D. J. Stokes, *Phil. Trans. R. Soc. Lond,* A 361 (2003) 2771

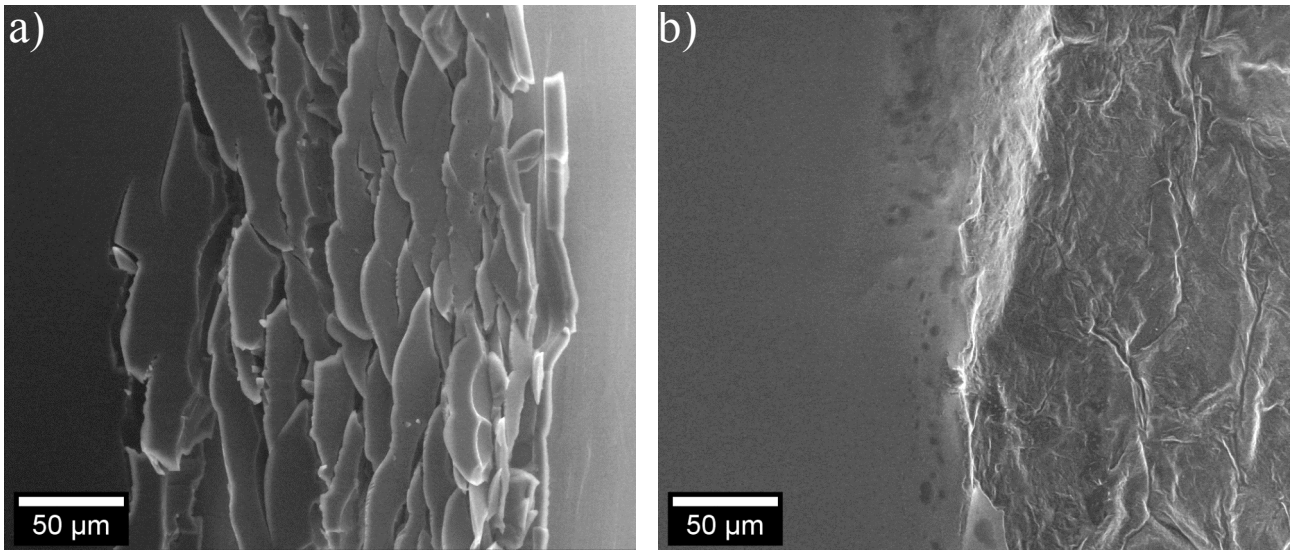

FIG. 1. a) SEM micrographs of a film former compound on (a) stainless steel and (b) stratum corneum

https://doi.org/10.1017/S1431927610055595 Published online by Cambridge University Press