THIN OPTICAL FILMS FRACTURE: BEHAVIOR WITH INCREASING TEMPERATURE

C. Baptista[1,2*], A. Dantas[2], C. Matos[2], V. Belchior[2], R. Martins[1], E. Fortunato[1]

[1] Materials Science Department, CENIMAT/I3N,
Faculty of Sciences and Technology of New University of Lisbon,
Campus de Caparica, 2829-516 Caparica, Portugal
[2] Essilor Portugal, Rua do Pino Verde 2, 2635-096, Rio de Mouro Portugal
[*] Presenting author

Abstract

Thin films and multilayered structures are increasingly employed in all sectors of modern industry. For example on an optical spectacle lens, multilayered are coated for various functions such as scratch resistance, anti-reflection, etc [1].

Coatings are needed on polymer ophthalmic lenses to enhance both the mechanical durability of the relatively soft plastic surface and the optical performance of the lens. High value ophthalmic spectacle lenses are coated with a multilayer system consisting of a primer coating, abrasion resistant hard coating and a multilayer AR coating stack [2]. The next figure shows the constitution of a coated spectacle lens:

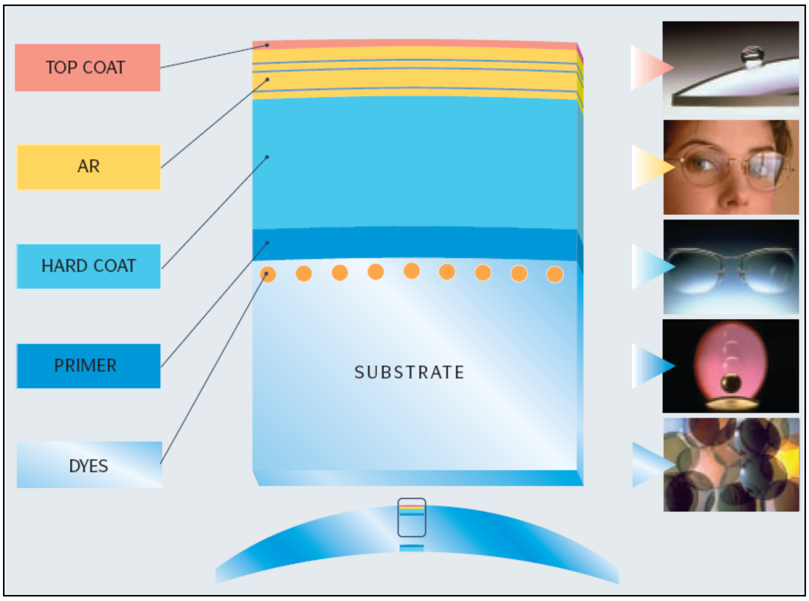

Figure 1 – A coated plastic lens is a complex system [3].

The optimization of coating performance continues to be a considerable technical challenge for the manufacturer of coated ophthalmic spectacle lenses.

This work presents a thin film testing temperature behavior performed inside a SEM system (FEI Quanta 400FEG / SEM), equipped with a heating system under high vacuum conditions. This study aims to simulate the use of ophthalmic lenses by the client, particularly in situations of sun exposure and heat set.

The SEM software allowed to obtain several movies *"in situ"* where it is possible to observe the evolution and behavior of the different thin films with increasing temperature.

The study involved dip-coating of ophthalmic lenses into a sol of controlled chemical composition (primer and hard coats) and electron beam deposition of Zirconia and Quartz interchangeably (AR coat). Allyl diglycol carbonate (CR-39™) was used as substrate because this is the most widely used thermosetting plastic material in ophthalmic companies [2,4,5].

Fractures in thin films propagate from small flaws in these. If this films were completely perfect and uniforms (almost impossible) they don´t peel or fracture. This way, and that the tests were controlled, there have been deliberate laser failures in order to observe the fractures associated.

The results show that the effect of temperature begins to become evident from the 40 º C (temperature perfectly fair in sunlight). These fractures are associated with the primer coat thermal expansion. This layer is relatively soft and elastic and is designed to buffer stress forces between the hard coat and substrate [2]. The hard coat cannot follow the expansion of the primer coat and eventually fracture.

Since temperatures above 70 º C major fractures are observed in the primer coat. The next figure shows the thin optical film microcracks evolution with the increasing temperature:

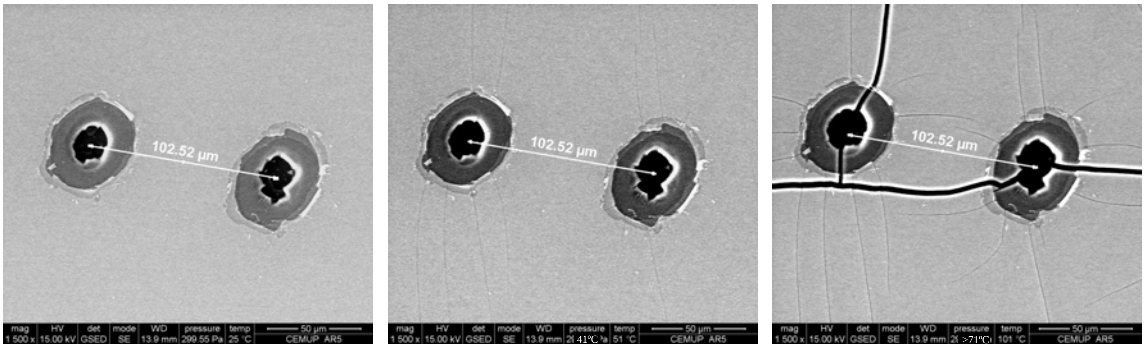

Figure 2 – Thin optical films evolution behavior with temperature.

Future works are being done using different substrate materials and thin film interface adhesion conditions.

Keywords: Thin films; SEM; Temperature; Ophthalmic.

Acknowledgement: The authors acknowledge the Portuguese Science Foundation (FCT) and Essilor Portugal for the financial support to the project SFRH/BDE/15656/2007 and CEMUP (Materials Centre of Porto University).

References:

[1] – Zhong Chen, Zhenghao Gan, Fracture toughnes measurement of thin films on compliant substrate using controlled buckling test, Thin Solid Films 515 (2007) 3305-3309

[2] – Frank Samson, Ophthalmic lens coatings, Surfaces and Coatings Technology 81 (1996) 70-86

[3] – Essilor, Coatings, Ophthalmic Optics Files (1997)

[4] – Essilor, Ophthalmic Optics Files – Lens Materials

[5] – D.R. Gunasegaram, I.M. Bidhendi, N.J. McCaffrey, Modelling the casting process of plastic ophthalmic lenses, International Journal of Machine Tools & Manufacture 40 (2000) 623-639