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Mechanical behavior of polyurethane polishers used in CMP

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Résumé :

Les polissoires en polyuréthane poreux sont largement utilisés dans le polissage mécano-chimique du verre optique. L'usure du polissoir est très importante et influe sur l'efficacité de polissage et la qualité de la surface. L'usure des polissoirs est observée lors de leurs soumission à des effets mécaniques particulièrement la compression, le fluage et l'incrustation des grains abrasifs. Pour cela, ce travail a pour objectif d'étudier le comportement mécanique des polissoirs en polyuréthane à savoir l'effet de la compression et du fluage et leur influence sur la qualité et l'efficacité du processus CMP.

Plusieurs tests mécaniques ont été effectués sur quelques types de polissoirs à savoir LP66, LP57 et le GR35 qui ont été récupérés durant l'opération de polissage. Le comportement des polissoirs durant les essais de compression et de fluage a été caractérisé. La qualité de la surface polie et l'efficacité du processus ont été également évaluées.

Abstract :

The porous polyurethane polishing pads are very used in the chemical mechanical polishing of optical glass. The pad wear is very important and influences the polishing effectiveness and the surface quality. The polishing pads wear is observed when they undergo changes in most cases caused by the influence of the mechanical effect as the compression, the creep and the abrasive grains incrustation. For that, this work has for subject to study the mechanical behavior of the filled polyurethane polishing pads in this case, the compression and the creep and their influence on the quality and the efficiency of the CMP process.

Several mechanical tests were conducted on polyurethane polishers LP66, LP57 and GR35 that have been recovered during the polishing operations. The pads behavior during the compression and creep tests was characterized. The polished surfaces quality and the process efficiency were also evaluated.

Keys words: polyurethane, polishing pads, compression module, creep, CMP.

1 Experimental procedure

The polishers used in this study are in polyurethane (supplier: Pieplow & Brandt) of different characteristics as the hardness, the filler and the densities (see Tab.1). Polishers were used in optical glass polishing operations for different periods, and they were recovered to be used in compression and creep tests.

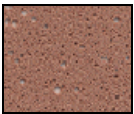
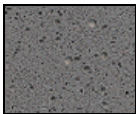

Polishers type	Shore hardness "D"	Density	Thickness [mm]	Filler
LP57	35	0.48- 0.64	0.51	not filled
LP66	25	0.35-0.51	0.51	Cerium oxide
GR35	37	0.56-0.67	0.51	Zirconium oxide
Color	LP66 	GR 35 	LP57 	

Table 1. Characteristics of the polyurethane polishing pads.

2 Results

2.1 The compression tests

The obtained results of the compression tests performed on the polyurethane polishers are presented in the following figures.

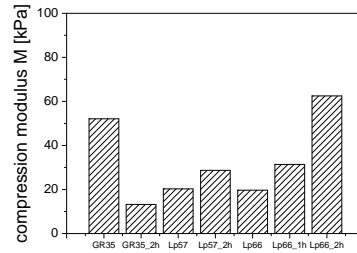


FIG. 1 – Variation of the compression modulus of the three polishing pads.

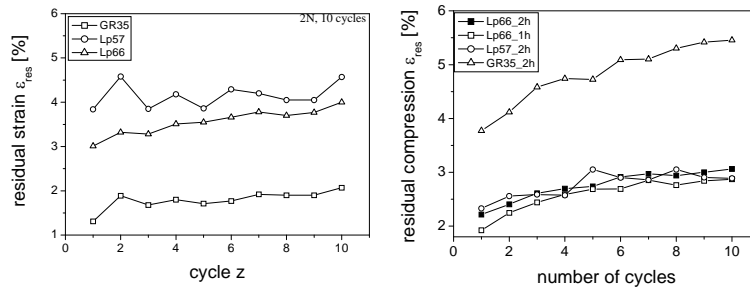


FIG. 2 – Evolution of the Hysteresis in the cyclic compression test (applied force: 2 N, 10 cycles)

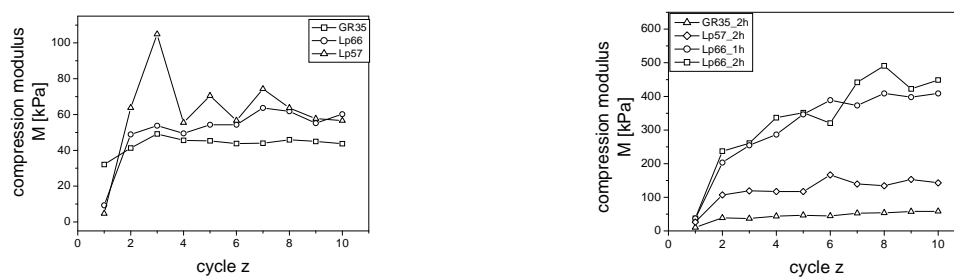


FIG. 3 – Variation of the Compression modulus obtained from load cycle (applied force :2N, 10 cycles).

2.2 The creep tests

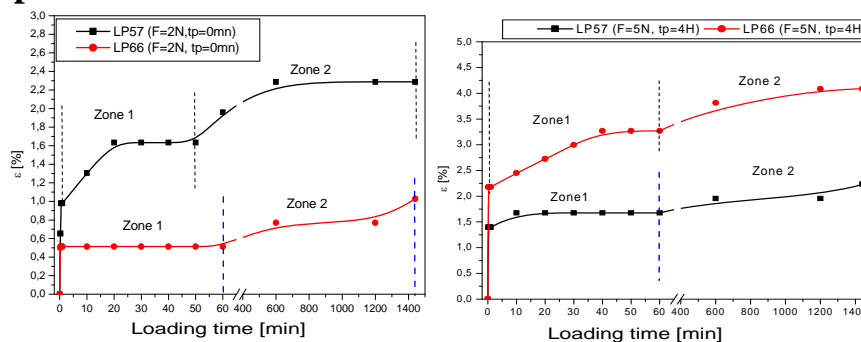


FIG. 4 – Variation of the deformation depending on the creep time.

Conclusion

The obtained results have shown that a variation of compression module was observed according to the polishers filling by the abrasive grains used in the polishing operation. The LP66 Polishers have more resistance to deformation before polishing and they become more sensitive after their use in polishing. Otherwise, it was found the existence of the creep phenomenon of polyurethane polishers. The polyurethane polishing pads creep is influenced by several parameters as polishing time, polishing load and loading time. While the deformation due to creep is proportional to the polishing time.