RELATIONSHIP BETWEEN BRIGHTNESS AND ROUGHNESS OF POLYPROPYLENE ABRADED SURFACES

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1. Introduction

The aim of this study consists in understanding the relationship between brightness and roughness of polypropylene surfaces abraded at different magnitudes. In this purpose, specimens were mechanically polished at different grades. This relationship is interpreted within the framework of the theory of optical reflection of surfaces which takes into consideration the local curvature radius of their asperities.

2. Materials and methods

Topography and brightness level were characterized by tactile profilometry and white light reflectometry at 3 angles respectively. About 100 roughness parameters were analyzed in this investigation.

3. Statistical analyses

A methodology designed to select the most relevant roughness parameter with regard to a correlation with the visual aspect (quantified by the brightness level measurements) is presented. Results select the fractal dimension as being the most relevant of them (figure 1).

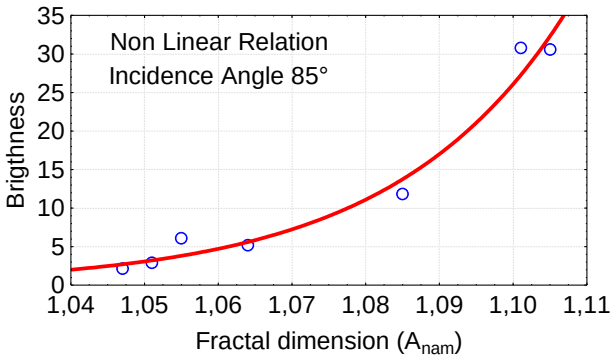

Figure 1. Nonlinear relation between the brightness and the fractal dimension of abraded surfaces

4. Interpretation

This relationship between brightness and fractal dimension is interpreted within the framework of the theory of optical reflection. In fact, the proposed approach provides an extension of the classical computation of curvature radii of peaks to fractal profiles by introducing a fractal concept of curvature radii of surfaces, depending on the observation scale and also numerically on horizontal lines intercepted by the studied profile [1].

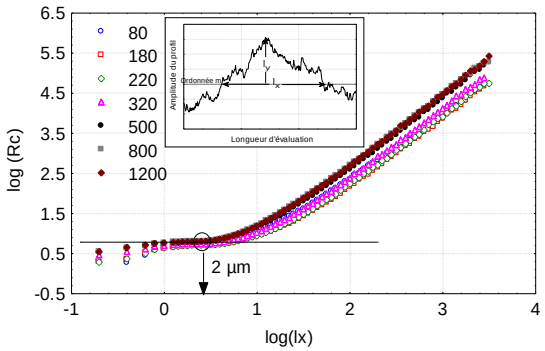

Figure 2. Evolution of the mean curvature radius versus the observation scale for each polishing grade

All abraded surfaces present different scaling laws (Figure 2). However, estimating the mean fractal curvature radius of asperities r_c at an optimal scale, the following power law emerges (Figure 3).

$$Brightness = \alpha\, r_c^{2.08}$$

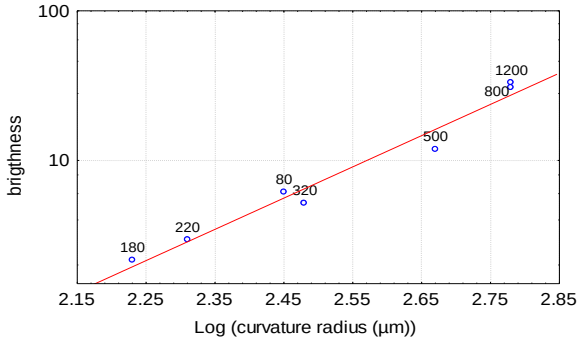

Figure 3. Evolution of the brightness with the mean fractal curvature radius r_c

5. Summary

The higher the fractal dimension of the polypropylene abraded surface, the higher its brightness level. Consequently, the brightness level of the abraded surface increases with the mean fractal curvature radius of its asperities estimated at an optimal scale.

6. References

[1] Bigerelle, M., Nianga J.M., Najjar D., Iost A., Hubert C., Kubiak K.J., Roughness signature of tribological contact calculated by a new method of peaks curvature radius estimation on fractal surfaces, Tribology International, 2013 (in press).