



A new method to control the roughness of different time trial garments. A preliminary study.

C. Leboeuf^{1,3}, *M. Cognard*³, *F. Grappe*¹, *X. Roizard*² and *F. Lallemand*³

¹ *Equipe cycliste Groupama-FDJ / Laboratoire C3S (EA 4660), Besançon (France)*

² *Institut FEMTO-ST (UMR CNRS 6174), Université de Bourgogne Franche-Comté, Besançon (France)*

³ *Société AFULudine SAS, Dole (France)*

contact e-mail: corentin.leboeuf@edu.univ-fcomte.fr

Background: Aerodynamics is one of the major factors in cycling performance. Textile optimization is one of the current means used to optimize performances (Brownlie, 2009 ; Chowdhury, 2010). In this context, the International Cycling Union (UCI) wants in 2019 to control the characteristics of textiles by limiting their external surface roughness (the modification of the surface condition must be limited to a height difference of 1 mm, article 1.3.033).

Purpose: The aim of this preliminary study is to propose a new method for measuring the roughness of the external surface of different time trial garments.

Methods: Eight TT garments with different roughness were tested in laboratory. The external surface of each garment was 3D modelled (fig. 1) using the Alicona® focus-variation microscope (fig. 2) and the data were analyzed using the Alicona® software.

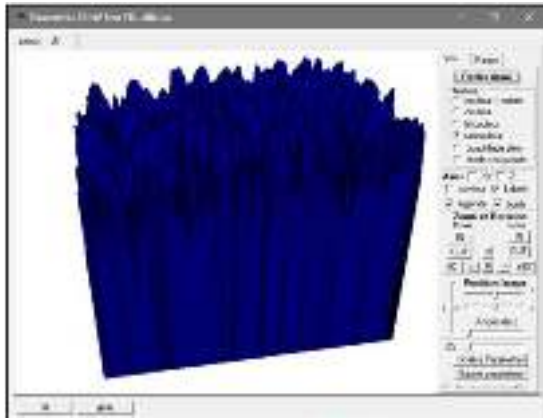


Figure 1: External surface 3D modelled

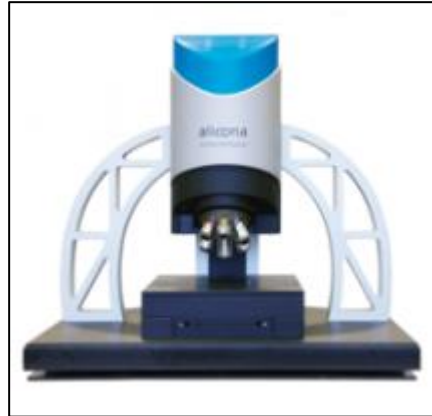


Figure 2 : Focal-variation microscope Alicona®

The roughness index was calculated using the mean plane defined by the software (fig. 3). The roughness index was expressed as an absolute value, the difference in height of each point compared to the arithmetical mean of the surface: $Sa = \frac{1}{A} \iint A |Z(x;y)| dx dy$.

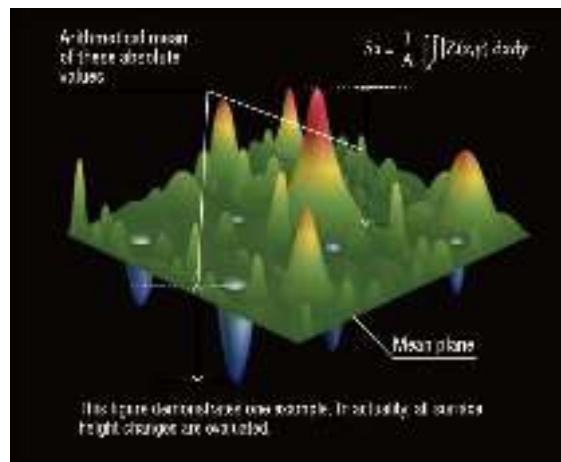


Figure 3: Illustration of calculation roughness index (Sa). Source : Keyence.com

Results: A roughness index (in micrometer, μm) was determined for each TT garment. The differences in roughness index between the different garments are presented in the figure 4 (from $17\mu\text{m}$ to $134\mu\text{m}$, $ES = 36.39$).

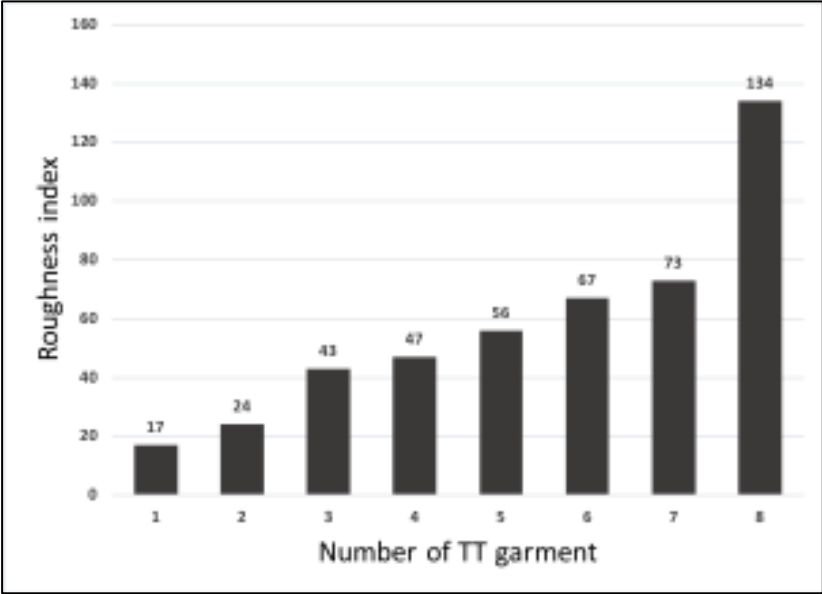


Figure 4: Characteristic of external surface condition

Discussion: This method provides a precise roughness index to determine the geometric characteristics of the external surface of a TT garment. The results show that each textile has its own surface roughness. However, it should be noted that it's possible the results obtained are related to the stretching of the garment during the measurement. This parameter must therefore be controlled and remain constant for all measurements.

Conclusion: The new proposed method makes possible the measurement of the textile surface roughness of TT garment thanks to the determination of a roughness index. It could allow the UCI to measure the surface roughness of the various TT garments of pro cycling teams and to check any modifications that do not comply with the regulations. But the method still needs to be refined to optimize the methodology.

Keywords: aerodynamics, textile, roughness, surface

References

- 1 Brownlie, L., Kyle, C., Carbo, J., Demarest, N., Harber, E., MacDonald, R., & Nordstrom, M. (2009). Streamlining the time trial apparel of cyclists: the Nike Swift Spin project. *Sports Technology*, 2(1-2), 53-60. <https://doi.org/10.1002/jst.12>
- 2 Chowdhury, H., Alam, F., & Subic, A. (2010). Aerodynamic performance evaluation of sports textile. *Procedia Engineering*, 2(2), 2517-2522. <https://doi.org/10.1016/j.proeng.2010.04.025>