# Specifying 3D roughness parameters for functional interfaces of dental components

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This investigation evaluated the possible contact stresses developed under dental implant/prosthetic pillar pair, considering the binding effect of biomaterials' surface characteristics on their functional performance. 3D surface parameters were used as input for the elastic contact model (Greenwood-Williamson). In this way, it was possible to specify a balance between Sq and Ssc roughness parameters to achieve small contact stress.

**Keywords:** 3D surface roughness, micromechanical contact, dental components

## 1. Introduction

During the mechanical contact between the dental implant and prosthetic pillar, the stress distribution is crucial. A lousy adaptation between these components under loading conditions can give rise to micro-slips, besides an opening for microorganisms that cause diseases [1, 2]. In this context, this investigation specifies a balance in the 3D roughness parameters to reduce the contact stress, helping the functions of adaptation and sealing of them.

## 2. Methods

Four samples were characterized using 3D optical interferometry:

i. A plate of Ti-6Al-4V alloy (2 x 30 x 40 mm³), obtained using wire electro-discharge machining (WEDM)
ii. The same sample of (i), but followed by an electropolishing
iii. A platform surface of a dental implant Ti-CP4, 4.1-mm diameter, machined by CNC
iv. A seating platform of prosthetic pillar Ti-6Al-4V ELI, 4.5-mm diameter, machined by CNC

The average values resulted from three measurements, corresponding to 0.19 x 0.39 mm$^2$, with 247 x 512 pixels of resolution. The parameters Sq (root-mean-square height), Ssc (curvature of summits), and Sds (density of summits) were applied to a well-known contact model [3]. Skewness and Kurtosis parameters were used to check the Gaussian distribution. The separation between surfaces (h) was based on the summit height standard deviation ($\sigma_s$). Equation (1) gives a fraction of the real contact area (Ac). We chose an apparent area ($A_0$) of 5 mm² (Figure 1), and the individual contacts were simulated using an applied load of 100 N, typical of static bite.

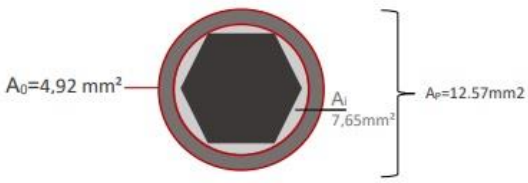


Figure 1: Possible areas considered in the contact between the dental implant and prosthetic pillar.

2.1. Basic equation

In equation (1), the summit radius (R) and the summit density ($D_{SUM}$) were calculated based on the roughness parameters Ssc and Sds, respectively.

$$\frac{A_c}{A_0} = \pi R \sigma_s D_{sum} F_1\left(\frac{d}{\sigma_s}\right) \quad (1)$$

## 3. Results

After testing different separation values for different combinations of contacts (surfaces i, ii, iii, and iv), the values for contact stresses are presented in Figure 2.

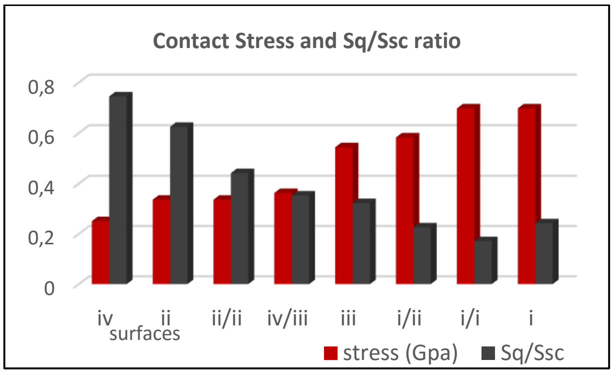


Figure 2: Contact stresses resulting from different Sq/Ssc ratios, using h = $\sigma_s$.

For a better contact stress distribution, this investigation addresses a higher Sq/Ssc ratio.

## 4. References

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