Electronic Supplementary Material (ESI) for Journal of Materials Chemistry B.

A light-sensitive protein-based wearable pH biometer

Wenxue Li[a, b], Siyuan Chen[c], Shiwang Xie[b], Xianmao Lu[a, b], Zhou Li[b]*, Yujia Lv[b]*, Dan Luo[b]*

[a] School of Chemistry and Chemical Engineering, Guangxi University, Nanning, 530004, China.

[b] CAS Center for Excellence in Nanoscience, Beijing Key Laboratory of Micro-nano Energy and Sensor, Beijing Institute of Nanoenergy and Nanosystems, Chinese Academy of Sciences, Beijing, 101400 China.

[c] School of Shanghai Pinghe, Shanghai, 201203, China.

*Corresponding authors. E-mail address: zli@binn.cas.cn; lvyujia@binn.cas.cn; luodan@binn.cas.cn

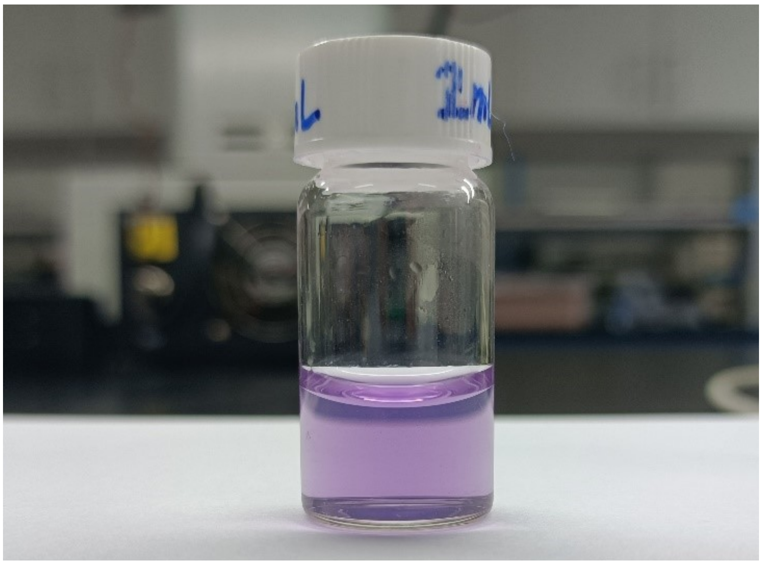

Figure S1. bR suspension.

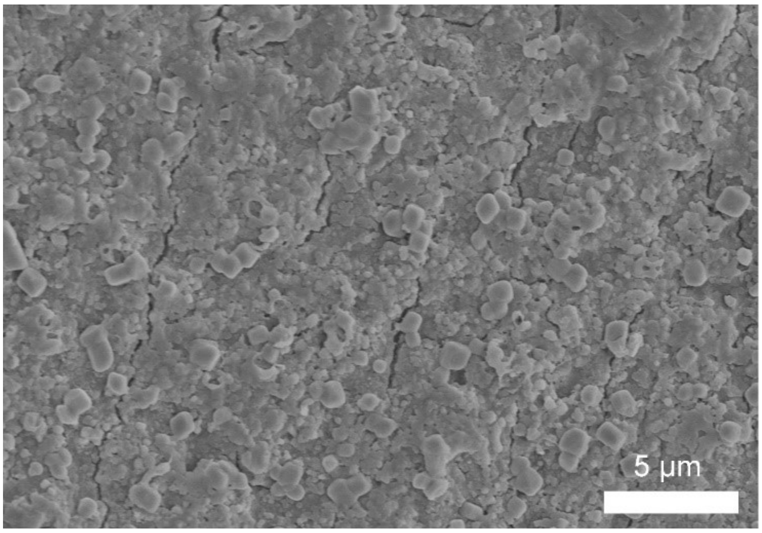

Figure S2. SEM plot of bRfilm.

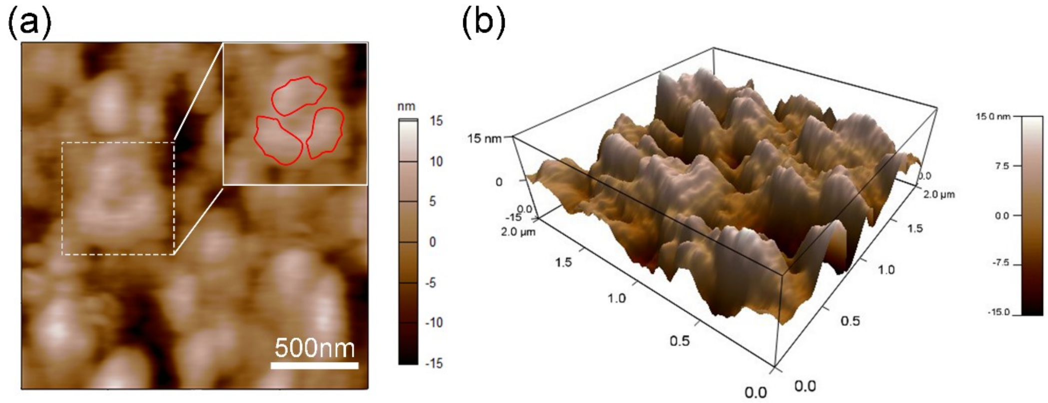

Figure S3. AFM diagram of the bR protein.

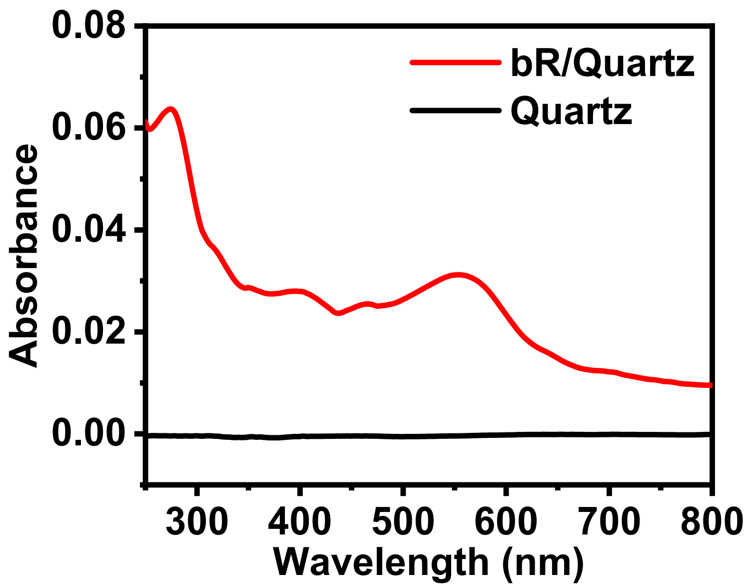

Figure S4. the UV-vis absorption spectrum of a bR film deposited on quartz glass.

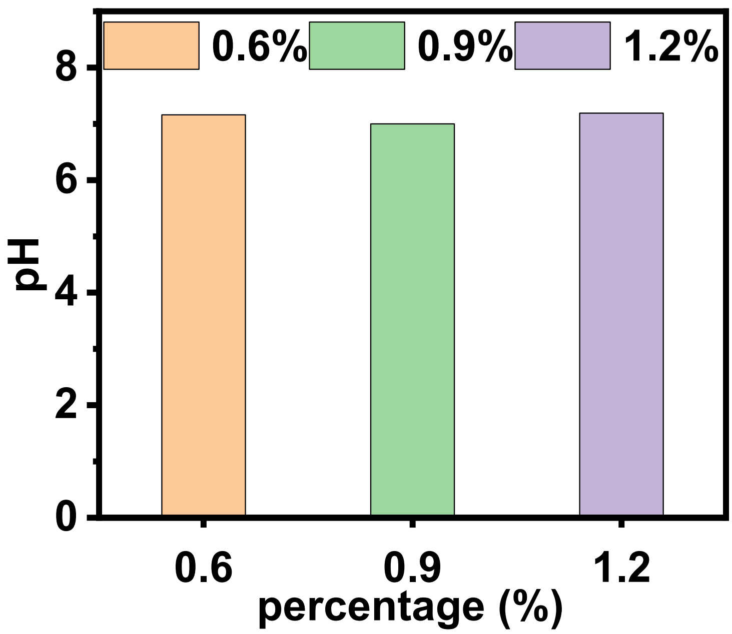

Figure S5. The pH value tested at different salt levels.

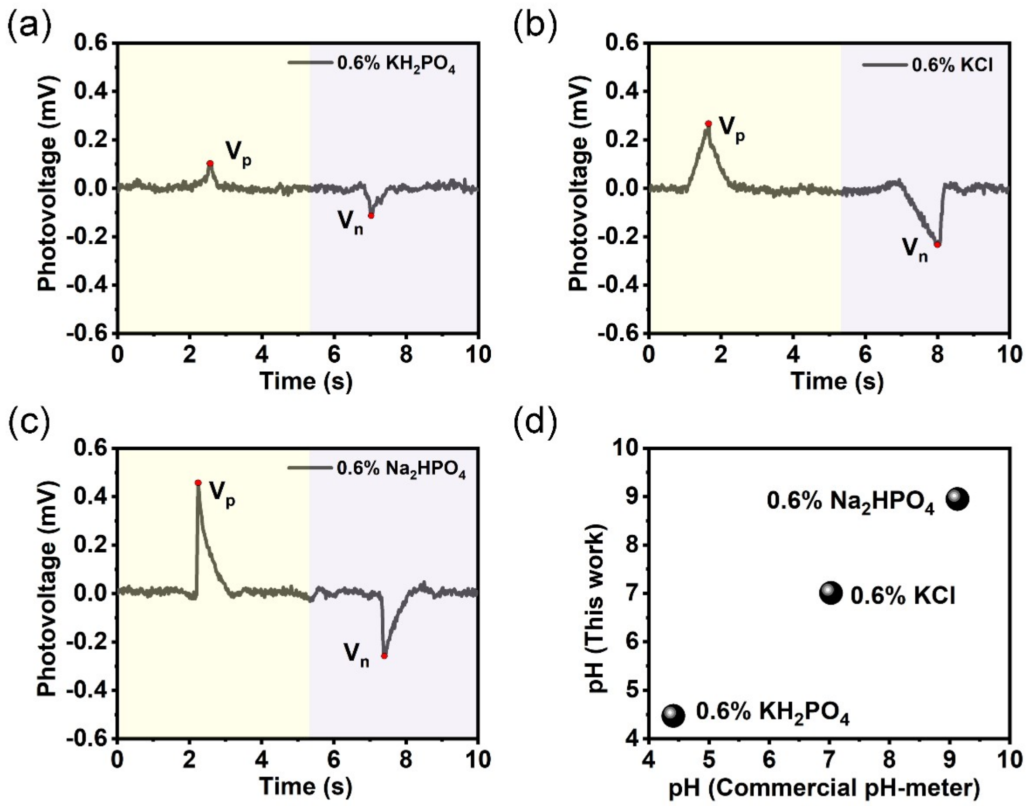

Figure S6. The pH value tested at different temperature.

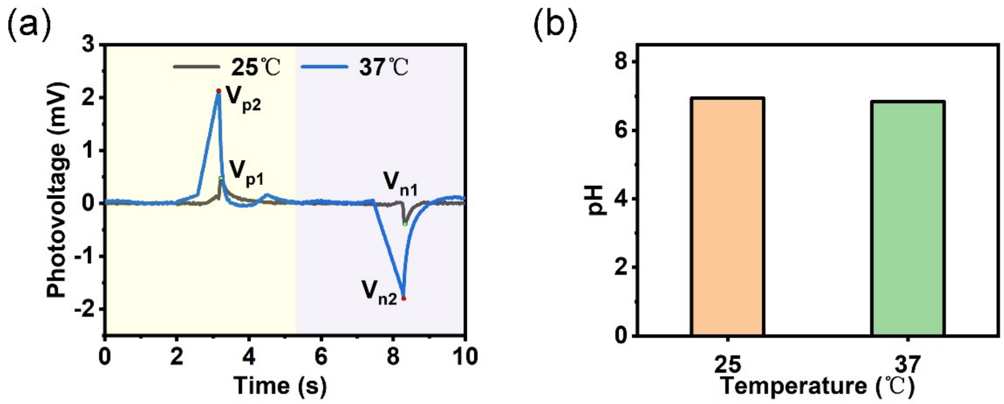

Figure S7. The pH value tested at different temperature.

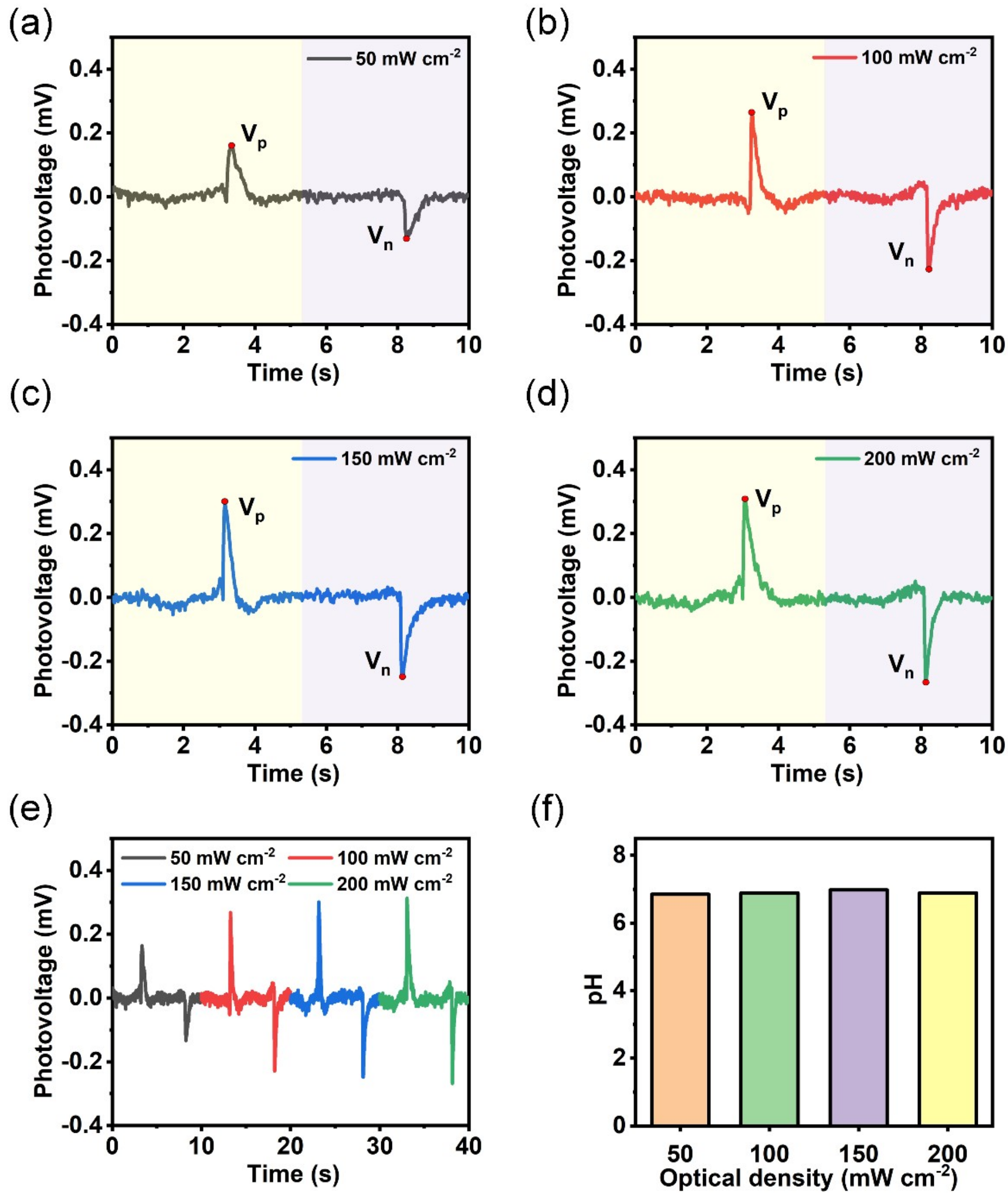

Figure S8. Performance output of the wearable pH biometer under different light densities.

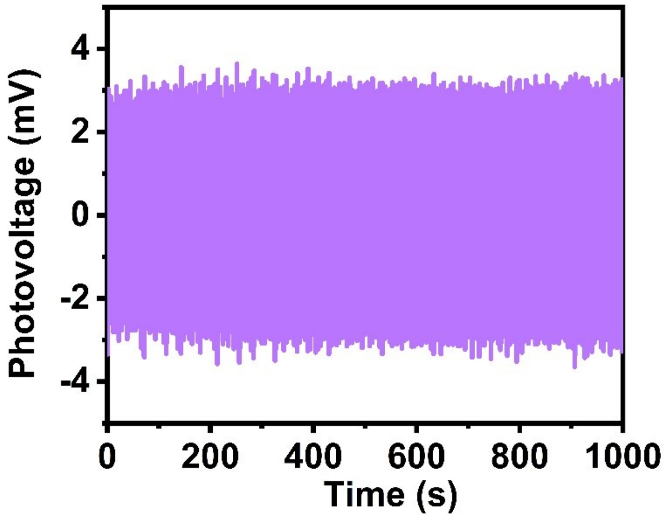

Figure S9. Stability of the wearable pH biometer with pH 7.0 under 1 Hz.

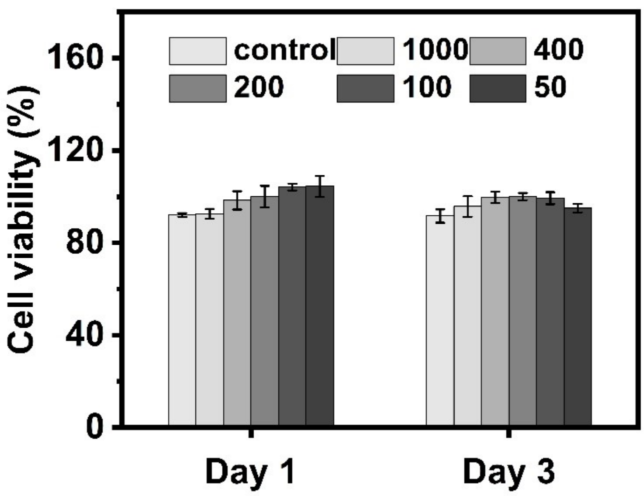

Figure S10. Biocompatibility plot of bR suspension at different dilution factors.

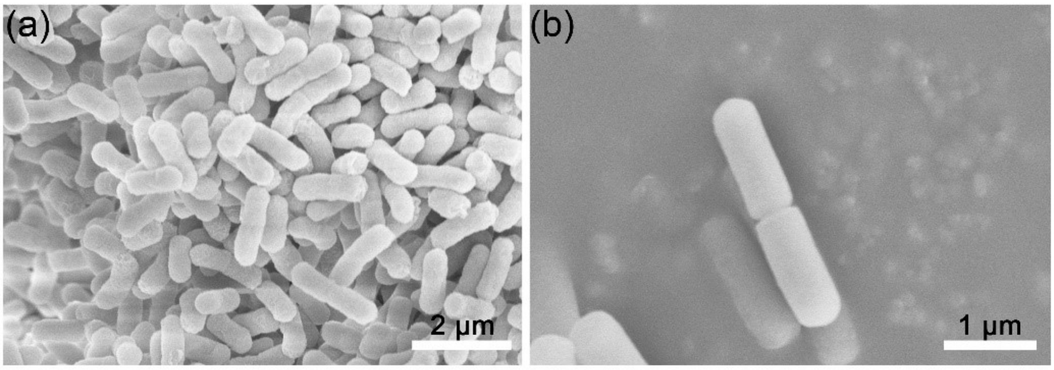

Figure S11. SEM diagram of E. coli at the time of wound infection.

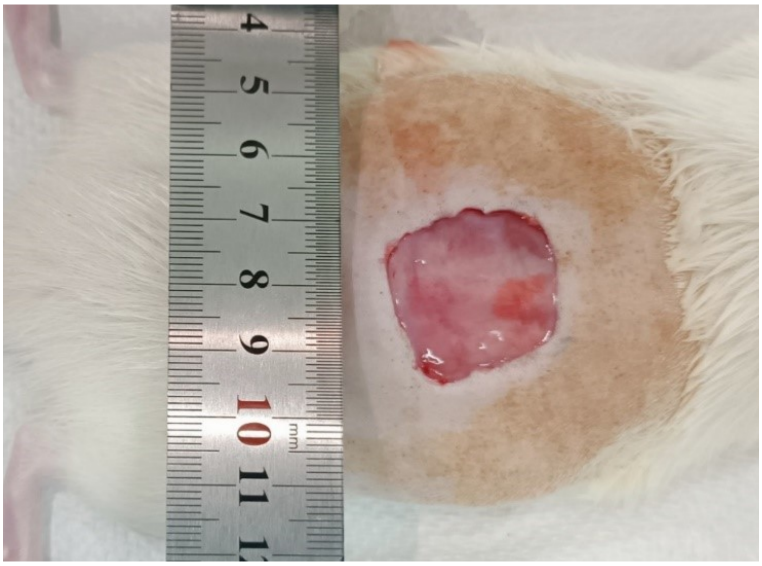

Figure S12. Schematic diagram of rat skin wound size.

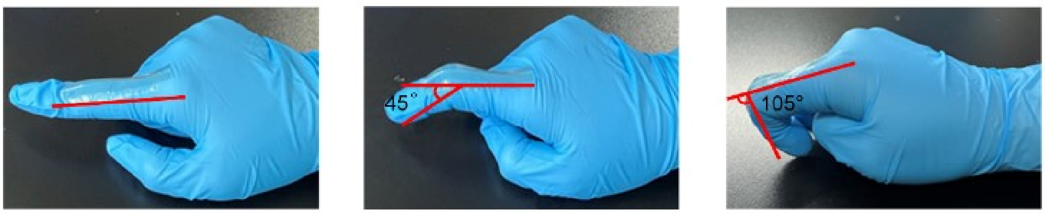

Figure S13. Bending of the PU film substrate on the fingers.

Supplementary Note 1. Calculation of bR suspension concentration

The concentration of bR suspension was calculated based on UV-visible absorption spectra. According to Lambert-Beer 's law:

$$A = \varepsilon \cdot b \cdot c \tag{1}$$

Where A is the absorbance, ε is the molar absorption coefficient of bR (63000mol^{-1} cm^{-1}), b is the optical path (1cm), c is the concentration of bR (mol·L^{-1}).

Therefore $c = \frac{A}{\varepsilon \cdot b}$, from the UV-Vis absorption spectrum of bR, the ratio of A_{280}/A_{568} is equal to 2.42, The molecular weight of bR is approximately 26,000 g mol^{-1}, so the concentration of the bR suspension used in this study is approximately 0.99 mg mL^{-1}.

Supplementary Note 2. Reliability test of pH biometer based on bR

There is a difference between the test value y_i (i =1, 2, 3...., n), and this difference can be expressed by the sum of squared deviations of the total deviation, that is, the sum of squared deviations between the test value y_i and the arithmetic mean $\bar{y}$, expressed below:

$$S_T = \sum_{i=1}^{n} (y_i - \bar{y})^2 = Lyy \tag{1}$$

$$L_{yy} = \sum_{i=1}^{n} (y_i - \bar{y})^2 = \sum_{i=1}^{n} y_i^2 - n\,(\bar{y})^2 \tag{2}$$

here are two reasons for this fluctuation in test values. One is the corresponding change in y caused by the change in x, which can be expressed by the sum of squares of deviations between the regression value $\hat{y}_i$ and the arithmetic mean $\bar{y}$, that is, the sum of regression squares, which is Equation 3:

$$S_R = \sum_{i=1}^{m} (\hat{y}_i - \bar{y})^2 \quad (3)$$

The second is random error, which can be expressed by the sum of squares of the deviations between the test value y_i and the corresponding regression value $\hat{y}_i$, that is, the residual sum of squares, that is:

$$S_e = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2 \quad (4)$$

It is clear that there is a relationship between these three sums of squares as follows:

$$S_T = S_R + S_e \quad (5)$$

However, the calculation of the regression sum of squares S_R and the sum of squares of residuals S_e is usually calculated as follows:

$$S_R = \sum_{i=1}^{m} (\hat{y}_i - \bar{y})^2 = b\, L_{xy} \quad (6)$$

$$S_e = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2 = L_{yy} - b\, L_{xy}\ (7) \quad (7)$$

The total deviation squared and S_T degrees of freedom are:

$$f_T = n - 1 \quad (8)$$

The degrees of freedom of the regression sum of squares are:

$$f_R = n \quad (9)$$

The degrees of freedom of the sum of squared residuals are:

$$f_e = n - 2 \quad (10)$$

It is clear that the relationship between the three degrees of freedom is:

$$f_T = f_R + f_e \tag{11}$$

Thus, the sum of squared deviations of each mean is:

$$V_R = \frac{S_R}{f_R} = S_R \tag{12}$$

$$V_e = \frac{S_e}{f_e} = \frac{S_e}{n-2} \tag{13}$$

Significance test with the F-test:

$$F = \frac{V_R}{V_e} = \frac{S_R}{\frac{S_e}{(n-2)}} = \frac{S_R(n-2)}{S_e} \tag{14}$$

The coefficient of determination R^2 is generally used in regression models to assess the degree to which the predicted and actual values match, and R^2 is defined as follows:

$$R^2 = \frac{S_R}{S_T} = \frac{bL_{yy}}{L_{yy}} \tag{15}$$

$$b\,L_{yy} = R^2\,L_{xy} \tag{16}$$

Therefore, the relationship between F and R^2 is as follows:

$$F = \frac{R^2(n-2)}{1-R^2} \tag{17}$$