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Supporting Information

Bionic Optical Physical Unclonable Functions for Authentication and Encryption

Yongbiao Wan,[‡ab] Pidong Wang,[‡ab] Feng Huang,[ab] Jun Yuan,[ab] Dong Li,[ab] Kun Chen,[ab] Jianbin Kang,[ab] Qian Li,[ab] Taiping Zhang,[ab] Song Sun,[ab] Zhiguang Qiu*[c] and Yao Yao*[ab]

[a] Microsystem & Terahertz Research Center, China Academy of Engineering Physics, Chengdu 610200, China.
Email: yaoyao_mtrc@caep.cn
[b] Institute of Electronic Engineering, China Academy of Engineering Physics, Mianyang 621999, China.
[c] School of Electronics and Information Technology, State Key Lab of Opto-Electronic Materials & Technologies, Guangdong Province Key Lab of Display Materials and Technologies, Sun Yat-sen University, Guangzhou 510275, China.
Email: zhiguangqiu88@gmail.com

[‡] These authors contributed equally to this work.

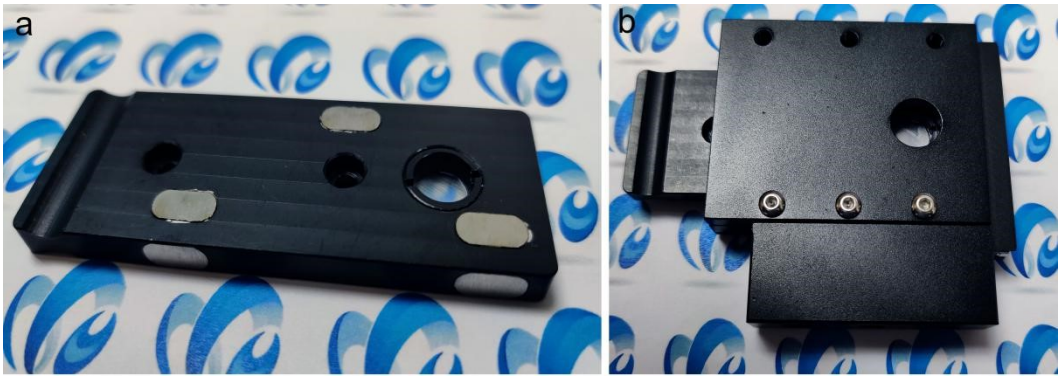

Fig. S1. The actual photos of a) a bionic PUF card and b) the slot inserted card.

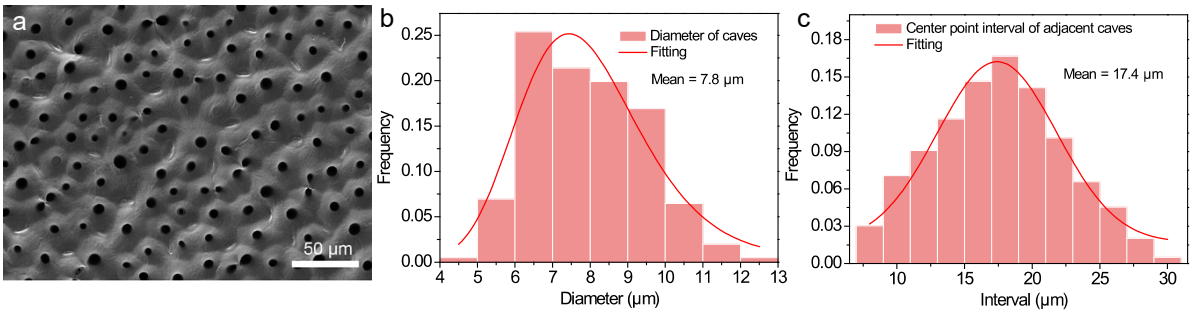

Fig. S2. a) Top view SEM image of lotus leaf based PDMS film. b) Statistical distribution of diameter of the caves in panel a, showing the average diameter of 7.8 μm and the distribution range from 4 μm to 13 μm. c) Statistical distribution of interval distance of the adjacent caves in panel a, demonstrating the average interval gap of 17.4 μm and the coverage from 9 μm to 30 μm.

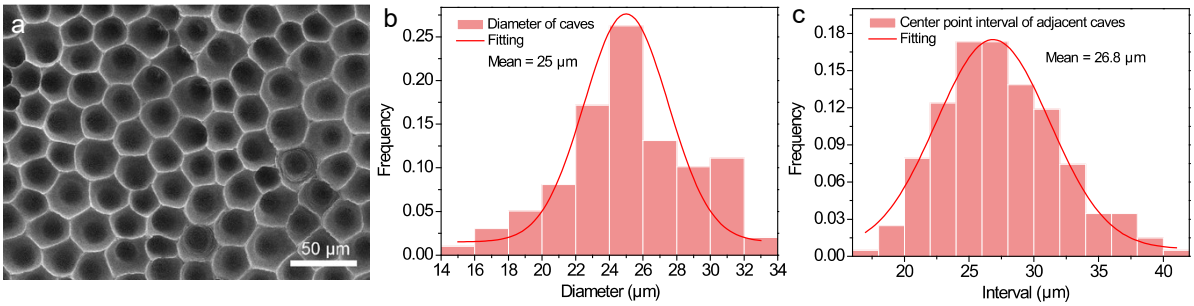

Fig. S3. a) Top view SEM image of rose petal based PVA film. b) Statistical distribution of diameter of the caves in panel a, showing the average diameter of 25 μm and the distribution range from 14 μm to 34 μm. c) Statistical distribution of center point interval distance of the adjacent caves in panel a, demonstrating the average interval gap of 26.8 μm and the coverage from 17 μm to 42 μm.

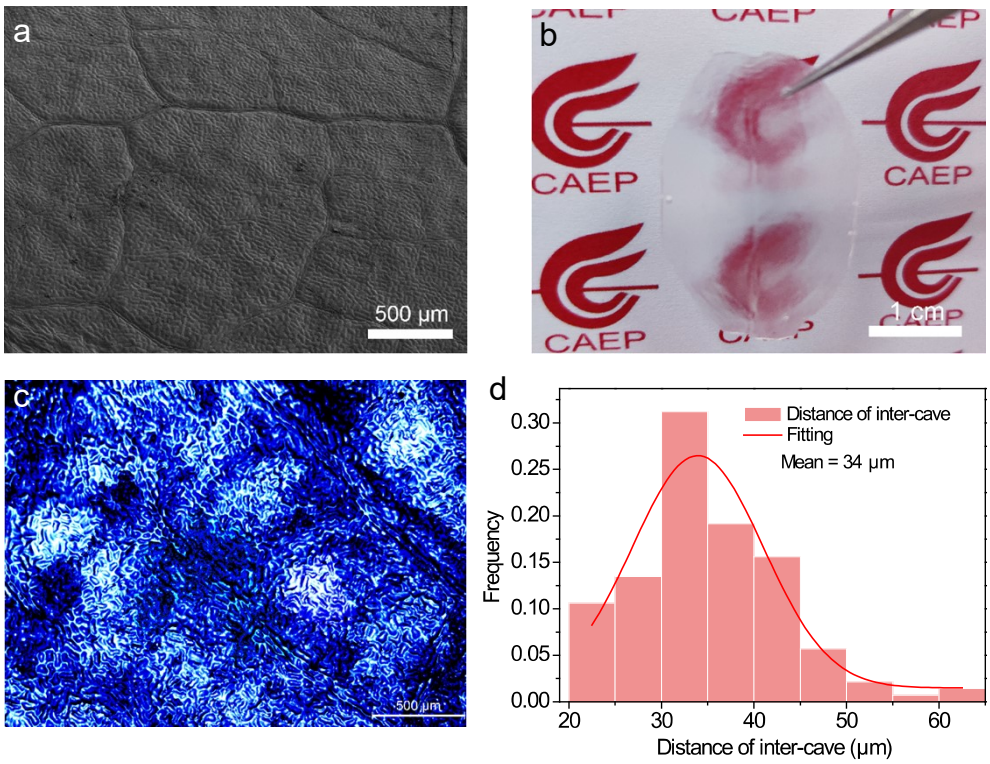

Fig. S4. a) SEM image of rose leaf. b) Photograph and c) top view optical morphology of rose leaf based bionic PDMS film. d) Statistical distribution of the distance of inter-cave in panel c, indicating the average interval gap of 34μm and the coverage from 20 μm to 65 μm.

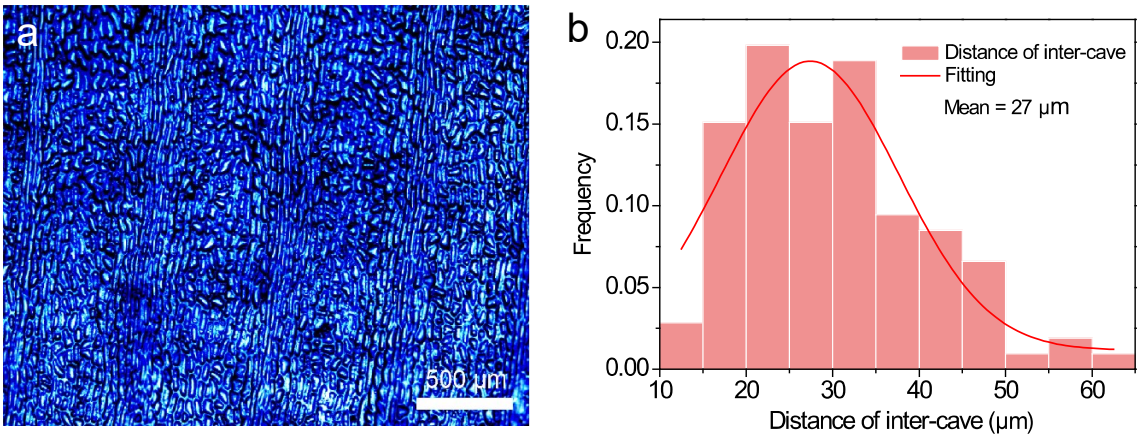

Fig. S5. a) Top-view optical morphology of ginkgo leaf based-bionic PDMS film. b) Statistical distribution of the distance of inter-cave in panel a, showing the average interval distance of 27 μm and the coverage from 10 μm to 65 μm.

Fig. S6. A random phase pattern for modulating the input laser beam, which creates a desirable challenge.

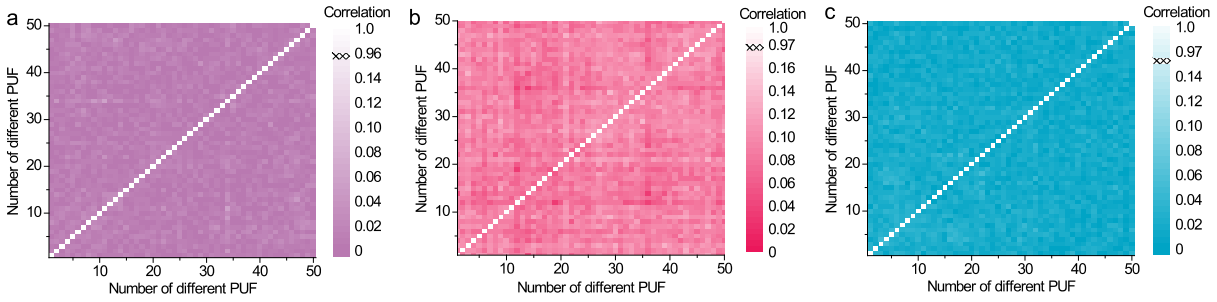

Fig. S7. Correlation coefficients of inter-chip PUFs based on a) rose petal, b) rose leaf, and c) ginkgo leaf, respectively. Inter-chip means that 50 different bionic PUFs were tested and compared with each other.

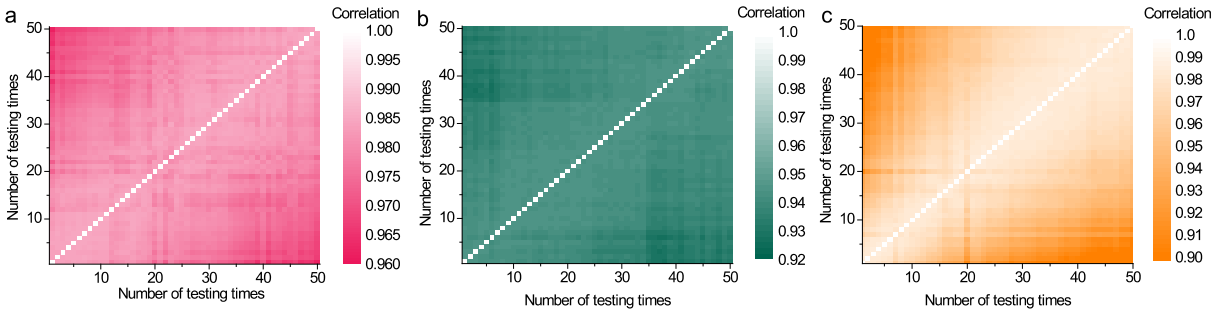

Fig. S8. Correlation coefficients of intra-chip PUFs based on a) rose petal, b) rose leaf, and c) ginkgo leaf, respectively. Intra-chip presents that one PUF card was repeatedly tested over 50 times.

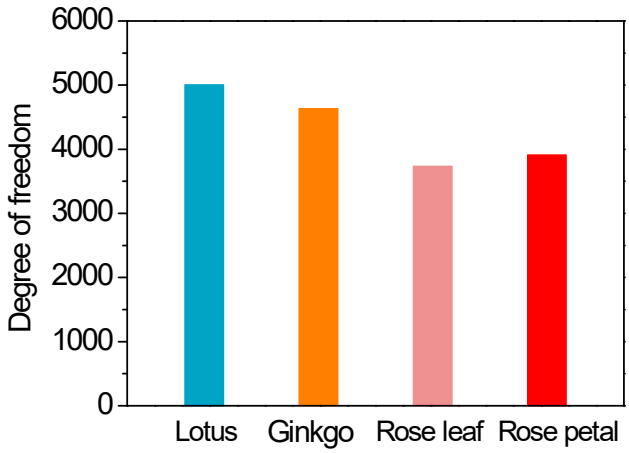

Fig. S9. Degree of freedom of these four kinds of bionic PUFs outputs.

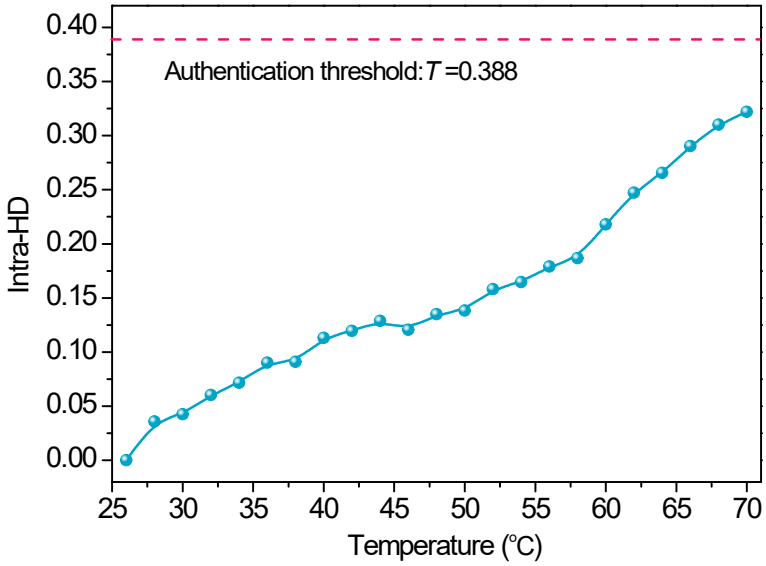

Fig. S10. Performance of the authentication protocol against thermal vibration. Intra-HDs ascend with increasing temperature while maintain below authentication threshold of 0.388, showing the reliability of PUF card within a certain temperature range.