# Quantum Light Scattering and Authenticated Communication

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Authentication is essential to ensure trust in communication in modern society and will play an even more important role in automated networks. In the past we have demonstrated authentication by the quantum-secure optical readout of a physical unclonable key (PUK) [1]. A PUK is a unique key which cannot be physically copied with existing or foreseeable technology. Multiple scattering samples form good PUKs. Recently, we have devised a quantum communication scheme based on optical PUKs employing readout with shaped complex wavefronts of weak coherent light pulses [2]. We also demonstrated a communication scheme using the transport and scrambling properties of a multimode fiber in combination with a single-photon sensitive camera [3] and started looking at temporal wavefront shaping for remote authentication via single-spatial-mode communication channels.

Formal proof of the unclonability of multiple scattering samples is virtually impossible since it depends on technological assumptions. However, in order to investigate the limits of state-of-the-art nanofabrication techniques, we started making multiple-scattering media by direct laser writing based on random space fillings with lines [4] and performed Xray tomography to check the fabricated samples. I will conclude this talk by discussing some potential applications of laser written deterministic scattering media.

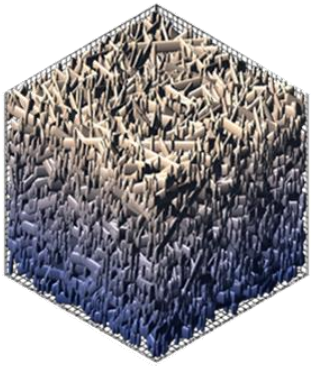

**Figure 1**: The $(20\ \mu m)^3$ 3D spatial structure of a DLW-written disordered polymer rod sample. The lighter shading indicates the features on top, while the features closer to the substrate are darker.

**References**

1. *Quantum-secure authentication of a physical unclonable key*, S. A. Goorden, M. Horstmann, A. P. Mosk, B. Škorić, and P. W. H. Pinkse, Optica **1**, 421 (2014).
2. *Asymmetric Cryptography with Physical Unclonable Keys*, R. Uppu, T. A. W. Wolterink, S. A. Goorden, B. Chen, B. Škorić, A. P. Mosk, and P. W. H. Pinkse, Quantum Sci. Tech. **4**, 04501 (2019).
3. *Quantum key establishment via a multimode fiber*, L. V. Amitonova, T. B. H. Tentrup, I. M. Vellekoop, and P. W. H. Pinkse, Opt. Express, in press; ArXiv: 1801.07180
4. *Uniform line fillings*, E. Marakis, M. C. Velsink, L. J. Corbijn van Willenswaard, R. Uppu, and P. W. H. Pinkse, Phys. Rev. E **99**, 043309:1-9 (2019)