# Effects of Humidity and Water Immersion on the Mechanical Properties of Silica Glass Surfaces

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Silica glass is known for its excellent chemical and thermal stability and is widely expected to be used in fields such as optical devices and biotechnology. However, the wetting behavior of its surface in air is complex due to its hydrophilicity. Therefore, it is important to understand how its surface structure and mechanical properties change depending on environmental conditions. In our previous work, we focused on the formation of nanoscale water droplets and thin liquid films on silica glass surfaces under varying humidity conditions, using frequency modulation atomic force microscopy (FM-AFM, prototype SPM-8000FM, Shimadzu Corp.) and PeakForce Tapping atomic force microscopy (PFT-AFM, Dimension XR Icon NanoElectrical, Bruker) [1]. These observations revealed that the surface of silica glass transformed into a granular structure approximately 10 nm in diameter after prolonged exposure to high humidity. Since this structure resembled the dissolution pattern of silica glass in alkaline solutions, it suggests that surface dissolution may occur under humid conditions due to the presence of adsorbed water. To investigate this possibility, we measured the adhesion force and Young's modulus of the silica surface before and after immersion in water. All measurements were performed at 25 °C. The silica glass surfaces were cleaned with piranha solution (80 °C, 10 minutes) and exposed to UV light for 15 minutes to remove organic contaminants. Measurements were taken in ultrapure water and under dry air (RH 20%). As a result, we observed an increase in the Young's modulus after immersion (Fig.1), indicating that the surface condition of the silica glass changed during contact with water.

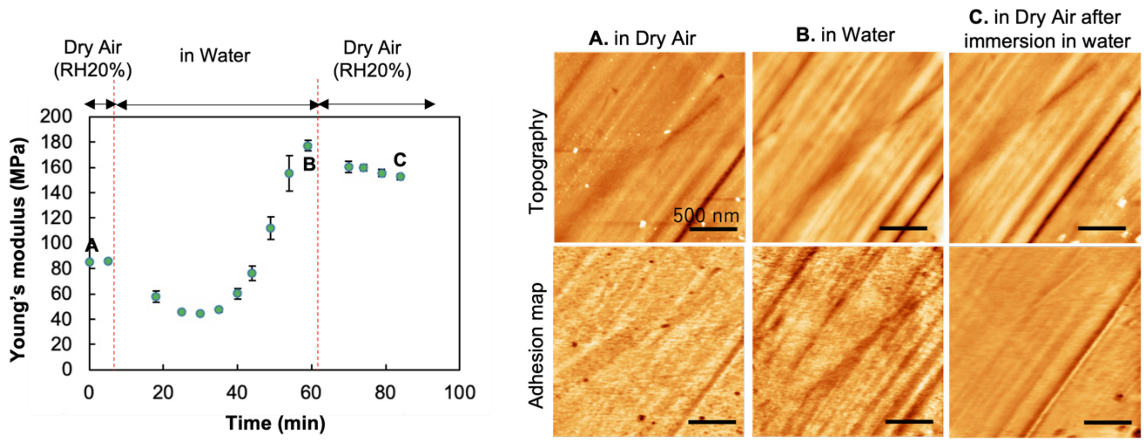


**Figure 1.** (Left) Changes in the Young's modulus of a silica glass surface under different environmental conditions. (Right) AFM topography images (top) and adhesion force maps (bottom) of the same surface, corresponding to points A, B, and C in the graph on the left. All scale bars represent 500 nm.

Reference

[1] Y. Araki, T. Minato, and T. Arai (2024) *Sci. Rep.* **14**, 10693.