



# Effects of sandblasting on the flexure strength reliability and the subcritical crack growth of the Y-TZP ceramics



Gong Xu<sup>1</sup>, Zhao Xinyi<sup>1,\*</sup>, Zhang Chunbao<sup>2</sup>, Li Shibao<sup>1</sup>, Wu Yulu<sup>2</sup>, Wu Bing<sup>2</sup>. 1. State Key Laboratory of Military Stomatology & National Clinical Research Center for Oral Diseases, Department of Dental Materials, School of Stomatology, The Fourth Military Medical University; 2. State Key Laboratory of Military Stomatology & National Clinical Research Center for Oral Diseases, Department of Laboratory Center, School of Stomatology, The Fourth Military Medical University.

**Objective:** The aim of this paper is to investigate the effects of cyclic loading and sandblasting on the fatigue fracture of Y-TZP ceramic and its mechanism.

**Methods:** Bar-shaped specimens of WL and HT were sandblasted with Al<sub>2</sub>O<sub>3</sub> and then were assigned to two groups (n=15) respectively: flexure strength test and cyclic loading fatigue test. The flexure strength tests were performed according to ISO standard and the cyclic loading fatigue tests were performed in a dynamic fatigue testing instrument. Afterwards, the flexural strength and the number of fatigue cycles to fracture was analyzed using Weibull statistics, and the subcritical crack propagation curve was plotted. Then the content of monoclinic zirconia of the sandblasted surface of the two Y-TZP ceramics was obtained from XRD and the microstructure of sandblasted surface was observed by SEM.

**Results:** After sandblasting, the flexural strength of WL and HT was 1291.48 ± 133.01 MPa and 1228.36 ± 137.33 MPa respectively, which was both higher than that of their no sandblasting specimens respectively (P < 0.05). The Weibull modulus of the two Y-TZP ceramics after sandblasting was 11.06 and 13.52, and the minimum rates of subcritical crack propagation was 6.89 × 10<sup>-12</sup> m/cycle and 7.6 × 10<sup>-13</sup> m/cycle respectively. The content of monoclinic zirconia on sandblasted surface was 12.5% and 11.1% respectively. On the sandblasted surface, parts of grains were broken off to form small pits.

**Conclusion:** Surface sandblasting is able to increase the flexure strength and its reliability of WL and HT, and their resistance to SCG can also be improved.

**Keywords:** Dental zirconia ceramic; Sandblasting; Weibull statistics; Flexural strength; Cyclic fatigue; Subcritical crack growth;

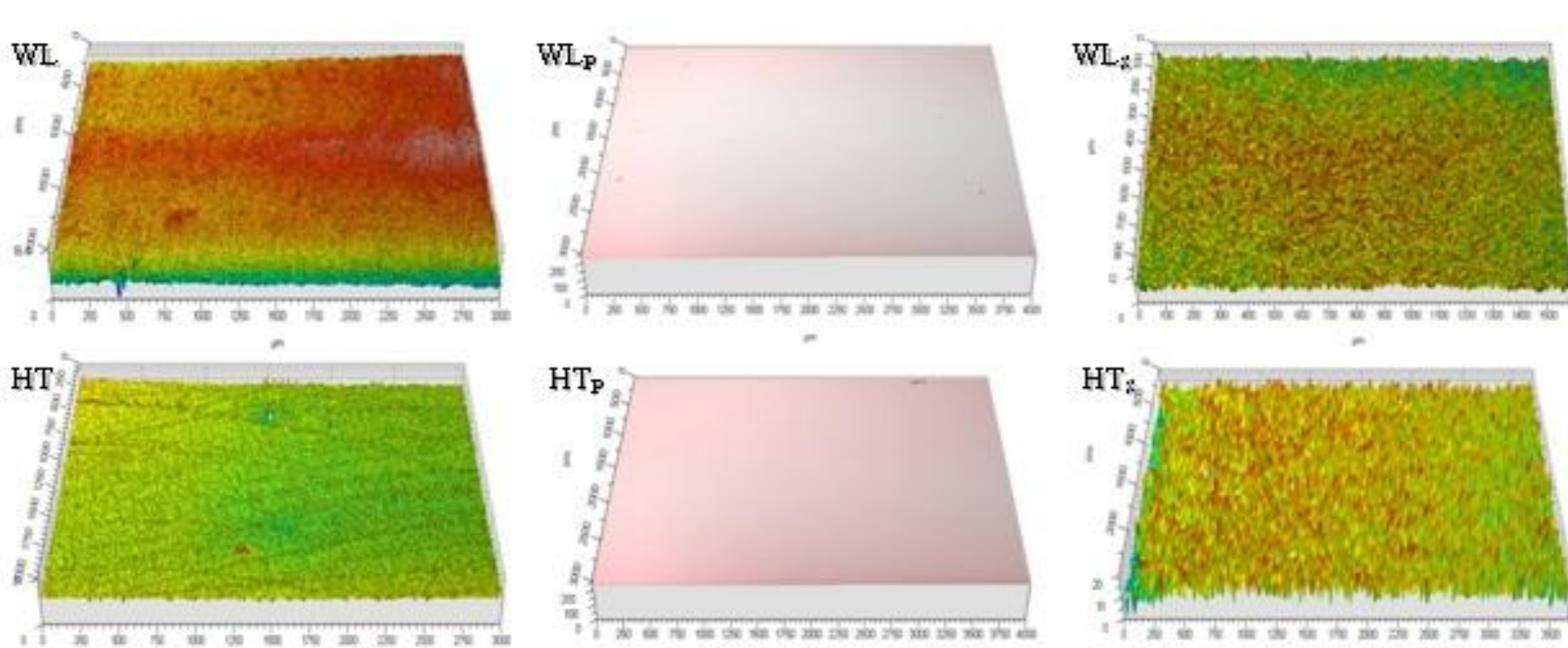


Fig1 The 3D view and the surface roughness of the WL and HT after sintering, polishing and sandblasting

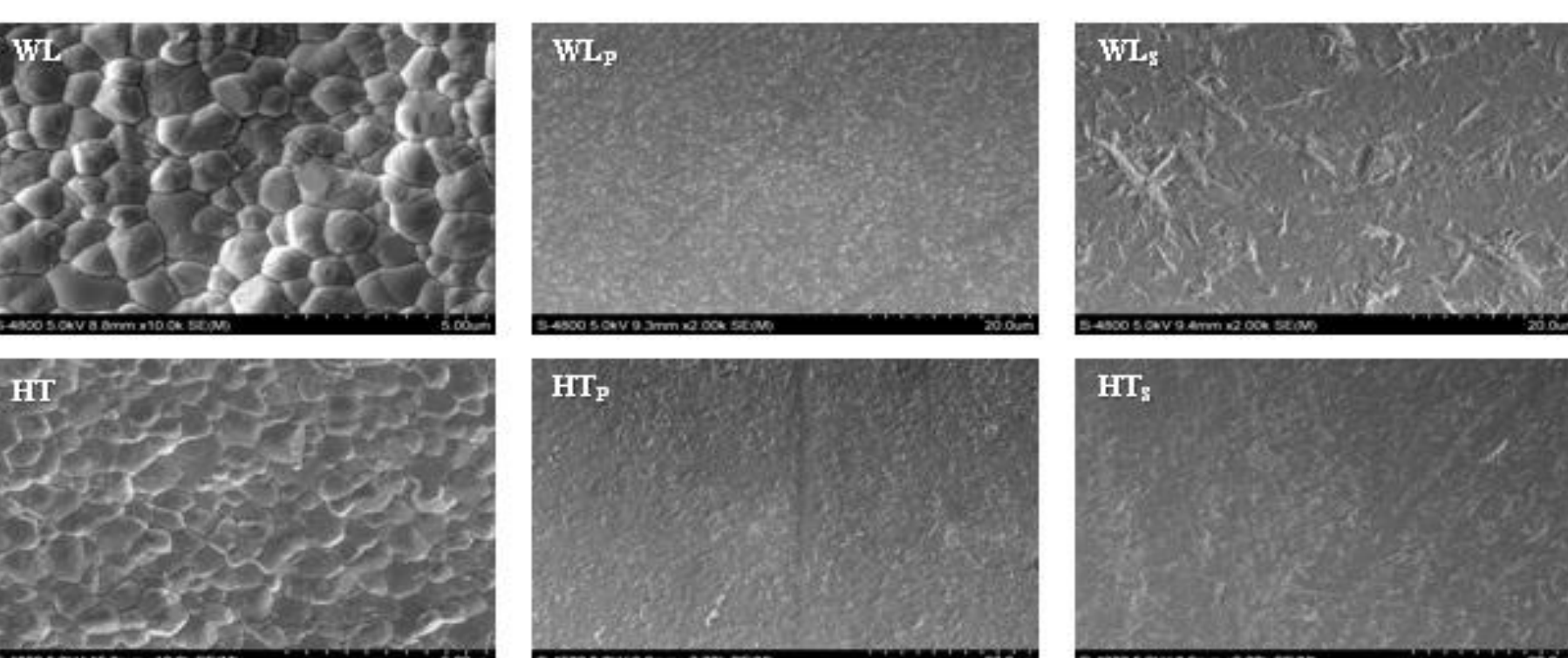


Fig2 The SEM picture of the WL and HT after sintering, polishing and sandblasting. The grain size of two Y-TZP ceramics after sintering was 0.5~1 μm and 0.5~1.5 μm respectively, and on the sandblasted surface, parts of grains were broken off to form small pits.

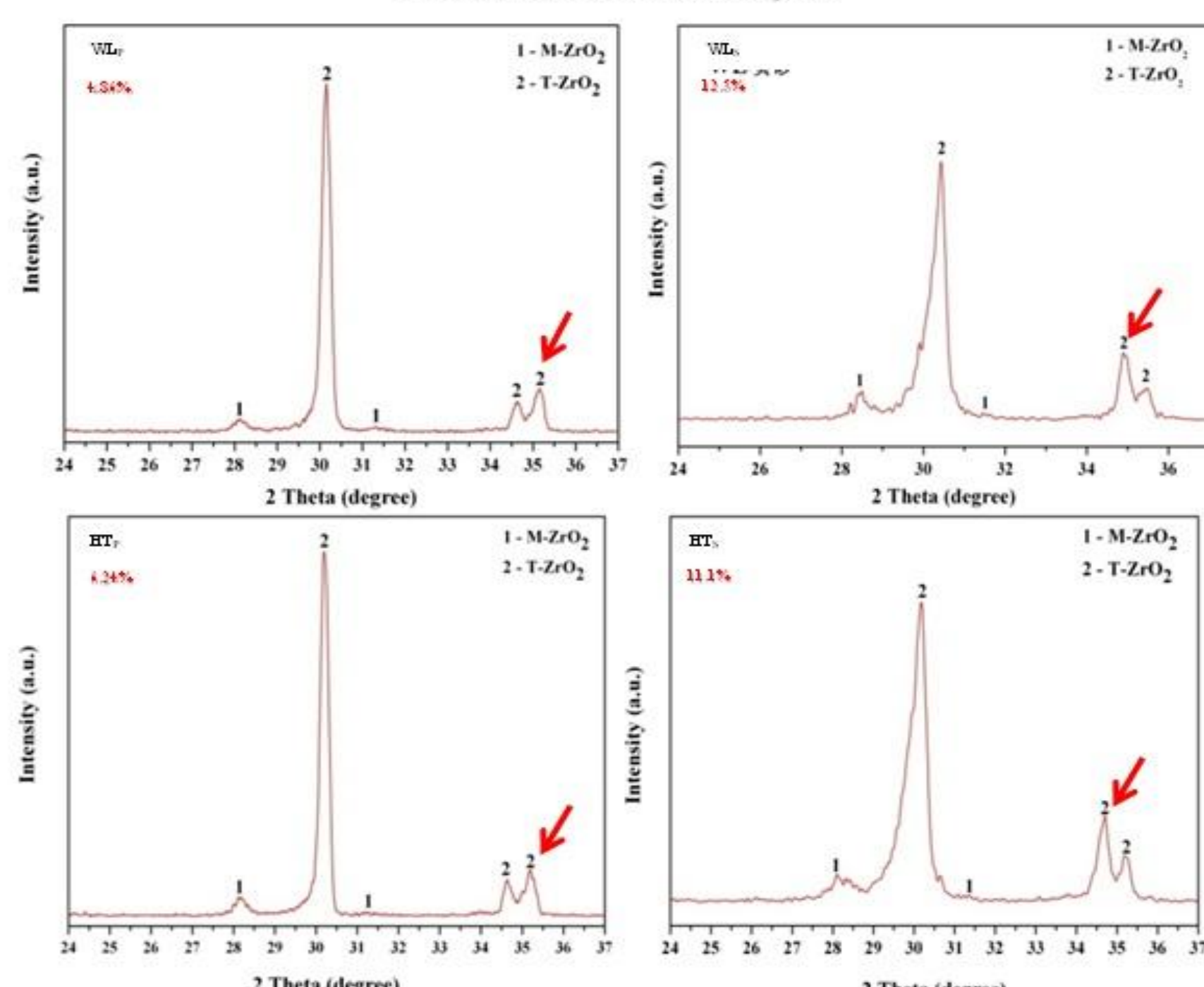


Fig6 The X-Ray diffraction of the WL and HT after polishing and sandblasting. The content of monoclinic zirconia on the surface of the two Y-TZP ceramics after polishing and sandblasting was (WL<sub>p</sub>)4.86%, (HT<sub>p</sub>)6.24%, (WL<sub>s</sub>)12.5% and (HT<sub>s</sub>)11.1%, respectively, which was both higher than that of their polishing specimens respectively

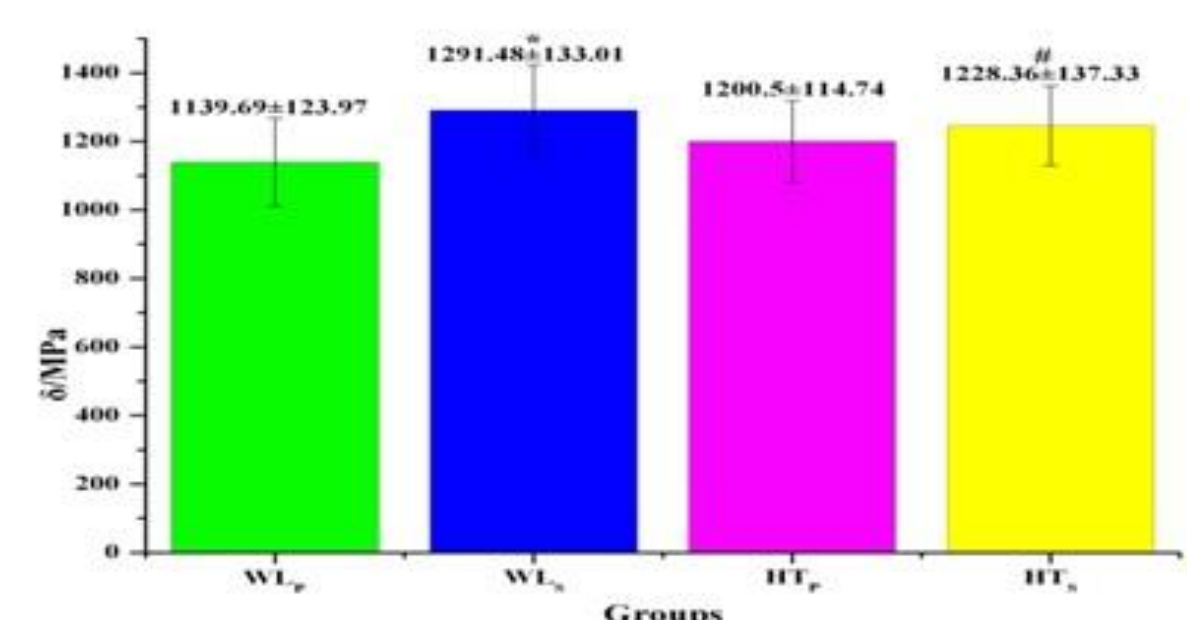


Fig3 The flexural strength of the WL and HT after polishing and sandblasting which was both higher than that of their polishing specimens respectively (WL<sub>p</sub> vs WL<sub>s</sub>, \* : P < 0.05; HT<sub>p</sub> vs HT<sub>s</sub>, # : P < 0.05).

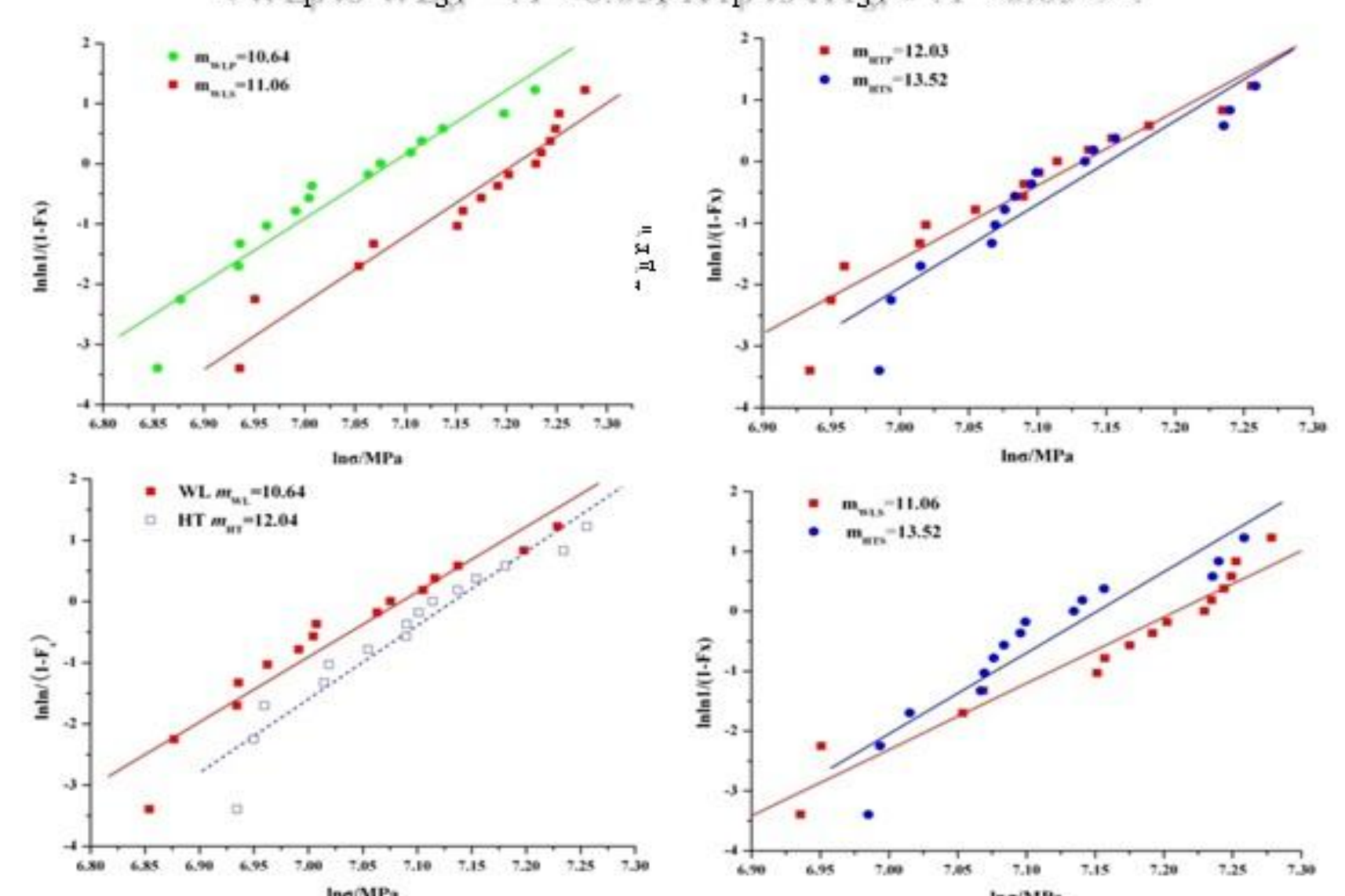


Fig4 The weibull distribution for the flexural strength of the WL and HT after polishing and sandblasting. The Weibull modulus of the two Y-TZP ceramics after sandblasting was 11.06 and 13.52, which was both higher than that of their no sandblasting specimens respectively.

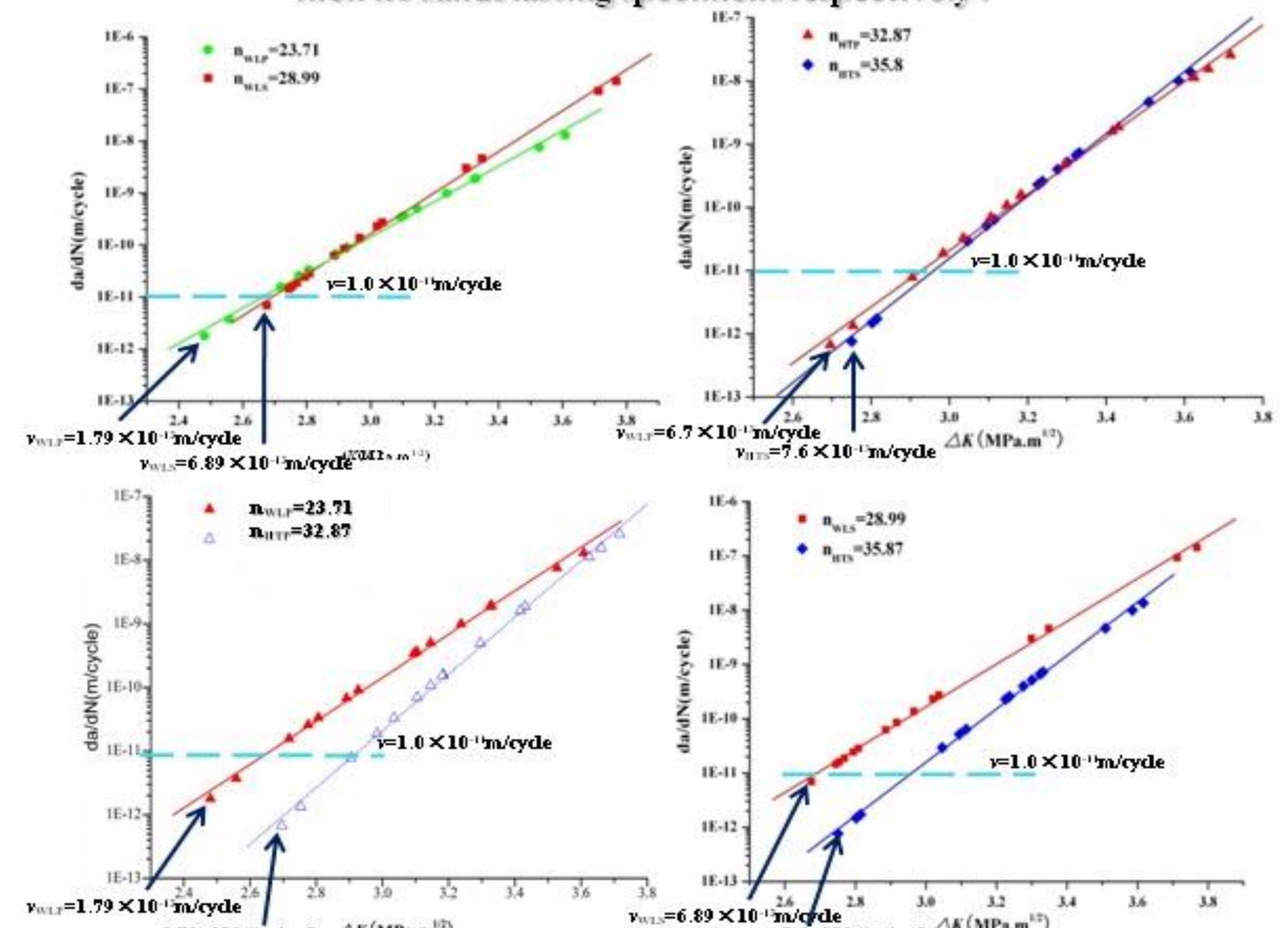


Fig5 The SCG curve of the WL and HT after polishing and sandblasting, and the minimum rates of subcritical crack propagation was 6.89 × 10<sup>-12</sup> m/cycle and 7.6 × 10<sup>-13</sup> m/cycle respectively, which was both higher than that of the polishing specimens respectively.