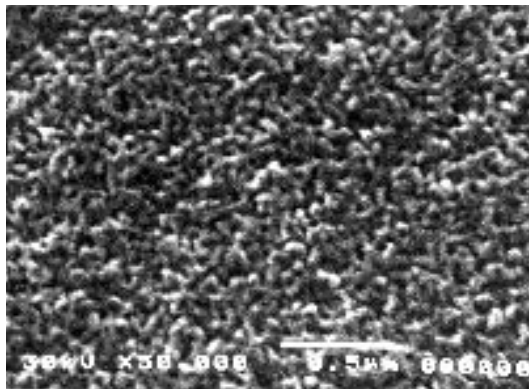
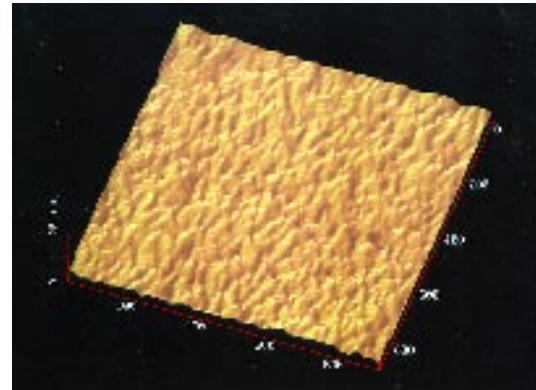
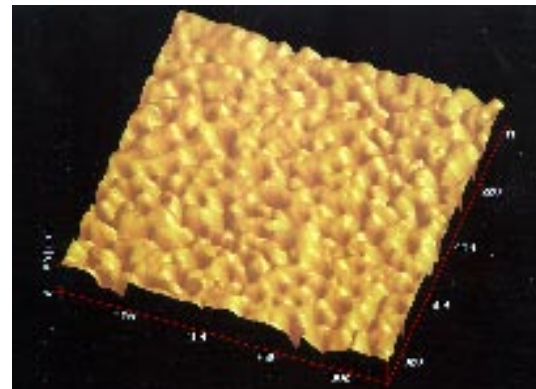


50 dishwasher cycles (Sun Micro)



50 dishwasher cycles (Sun)



SEM images of flat glazed plates (black glaze on unknown body).

AFM images of an area of (1×1) µm² of flat glazed plates (black glaze on unknown body).

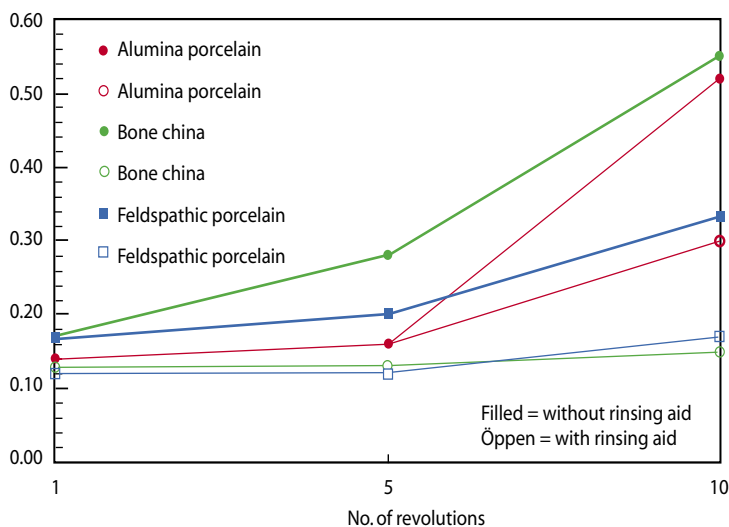
Glazed ceramic tableware, sanitary ware, tiles, and electrical porcelain are affected by chemical and mechanical attacks that alter the surface properties and the microstructure. Ceramic tableware is exposed to chemical corrosion during the washing-up in dishwashers because of the high alkalinity of the washing-up detergent solution. The glazed surface is mechanically attacked through the use of cutlery and from contacts between two cups or two plates.

The chemical stability of glassware and glazes is lower in alkaline solutions than in acidic or neutral solutions owing to the acidic glassy phase. This is the main reason for the corrosion in connection with dishwasher solutions. The low-alkaline washing-up detergents are less harmful to the glaze but, there is still a notable chemical corrosion. Industrial dishwashers use more high-alkaline washing-up detergents than what is used in household equipment and the corrosion is thus more pronounced.

SCI has been investigating the wear resistance of

glaze compositions for a number of years, in particular the correlation between the wear performance and the composition of the glaze, the microstructure of the glaze, the use of rinsing agents and the type of wear couples (glaze – steel, glaze – glaze or glaze – unglazed ceramic body). The chemical corrosion caused by repeated dishwasher cycles is apparent as a matt surface. It is even more easily seen on a drinking glass, which becomes milky and opaque. Detailed investigations of the differences in chemical corrosion related to the glaze composition or the washing-up detergent require a close investigation of the surface topography. Both scanning Electron Microscopy (SEM) and Atomic Force Microscopy (AFM) are suitable analytical methods.

The wear resistance of selected glaze compositions was investigated by performing wear tests following the “ball-on-disk” principle with a loaded ball in contact with a rotating plate. The loaded ball may be made either of steel or of ceramics to simulate the



The figure illustrates the variation of the coefficient of friction with the number of revolutions in one and the same track. The difference is also well documented in the view of the wear tracks. Crack formation starts much earlier when no rinsing agent has been used. The cracks may cause a darkening of the surface as metal fragments from the cutlery stick to the cracks.

contact with cutlery or with another plate. The use of rinsing agents in the washing-up has a positive effect on the wear resistance.

There are a number of standardised test methods available to evaluate the resistance to chemical corrosion of ceramic glazes and glassware. The methods involve a large number of repeated dishwasher cycles. As a complement to these labour-intensive and long-term running test methods, rapid

methods are used in which the specimens are dipped into high-alkaline solutions. The glazed surfaces of plates exposed to as much as 650 repeated dishwasher cycles using different washing-up detergents have been closely analysed using SEM and AFM. It has been shown that AFM is sufficiently sensitive to detect minor changes in the surface topography. Heavily attacked glazed surfaces can be verified in a SEM as well.

References

The Swedish Ceramic Institute has, among other things, published the following papers within this field:

Wear Properties of Glazed Ceramic Tableware, Karlsson S & Carlsson R, Third Euro-Ceramics, Vol. 2, "Properties of Ceramics", 1047-52, 1993

Evaluation of the Chemical Corrosion of Glazed Tableware on a Microscale, Karlsson S, Ceramica Acta, 13 [1-2] 50-61, 2001

Evaluation of Chemical Corrosion of Tableware Glazes by Atomic Force Microscopy, Karlsson S & Iwasa M, cfi/Ber. DKG, 77[3] 12-18, 2000

Contact us for more information

Do not hesitate to contact us if you want to have more information or have specific questions that you want to discuss. Based on your requests and needs we can provide a quotation.

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The Swedish Ceramic Institute (SCI) is a division of IVF and works with product oriented research and development of ceramics and related materials.

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