MODIFICATION OF SURFACES BY TEXTURING

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ABSTRACT

An rf-ion source of 10 cm diam utilizing Xenon has been developed (beam density 0.8 mA/cm²). We textured Al (with seed material Mo), teflon (with SS and Mo), SS (with Mo and Ta), and Cu (with SS). Microphotos have been taken. - It exists a critical specimen temperature, below which no texturing occurred. The height growth of the surface structure depends linear on the exposure time and sublinear on the sample temperature.

1. INTRODUCTION

Since a few years a new effect on surface modification - the ion beam texturing (and ion beam etching) - is investigated (1). For this purpose, the target (to be textured) and the seeding material are exposed to the same ion beam (Fig. 1). Atoms of the seeding material which are sputtered onto the target (Fig. 2), agglomerate there into microscopic areas, where they protect the target-substrate against sputtering by the impinging beam ions. Microscopic cones and ridge - like structures are formed (see Fig. 5 and 7). - The chemical and physical applications of textured materials are determined by the produced surface structure:

- o enlargement of catalytic reaction rates (increase of surfaces)
- o increase of the adhesive strength of thin layers
- o reduction of the secondary emission coefficient
- o decrease of sputter-rates
- o change in emissivity and reflectivity (depending on the angle of incidence)

Textured inorganic and organic biomedical implants show improved attachment to soft and hard tissues and to bone cement, as well as improved tissue response (2).

2. EXPERIMENTAL

2.1 ION SOURCE: For the texturing investigations, an rf-ion source has been developed (Fig. 3) (3). The discharge vessel, made of quartz (diameter 8.6 cm, height 10 cm), is surrounded by the rf-induction coil. The working gas Xe is ionized by the induced eddy rf-field of the induction-coil. The ion extraction is accomplished at 2.5 kV via 7 extraction holes (diameter 2 mm). The plasma holder, also made of quartz, protects the extraction cathode against the discharge plasma.

The performance data of the ion source are

- o discharge pressure 1.06 µbar
- o discharge power 60 ÷ 80 W
- o rf-frequency 1.6 MHz
- o beam density 0.6 ÷ 0.8 mA/cm^2 (6 cm down-stream the extraction cathode)
- o net beam voltage 2.2 ÷ 2.5 kV

2.3 SEED AND TEXTURING TARGET: The actual texturing target (12 x 12 x 3 mm) with the seed material is shown by Fig. 4. The support can be heated up to 700°C by a coaxial heater. The temperature is reported by a thermocouple.

2.4 MEASUREMENTS: We textured Cu (with steel), Al (with Mo), teflon (with steel and Mo), and steel (with Mo and Ta) in dependence of the target temperature and the ion dose (3). As examples Fig. 5 and 6 show scanning electron photomicrographs of a conical and a ridge-like structure.

3. RESULTS

At a constant inpinging ion dose of 15 $mA \cdot min \cdot cm^{-2}$, Cu-samples had been textured at temperatures up to 660°C. In accordance to a simple theoretical model, developed by the first author (3), we could verify the existance of a critical sample temperature at 250°C below which no texturing occured. Fig. 7 illustrates this relationship. The physical background is not yet quite well understood.

At a constant beam density (0.7 mA/cm^2), the dose had been changed by varying the exposure time (3 ÷ 100 min). The area density of the cones (Cu-sample) is independent on the dose. The cones increase only in height and diameter. This is also in accordance with the texturing model (3). The height growth of the surface structures depends, as shown in Fig. 8, linear on the ion dose.

REFERENCES

(1) W.R. Hudson, Journ. Vac. Sci. Technol. 14, 286 (1977)

(2) B.A. Banks, NASA TM-81721, 1981

(3) G. Bonarius, Thesis (in German), Giessen University, June 1980

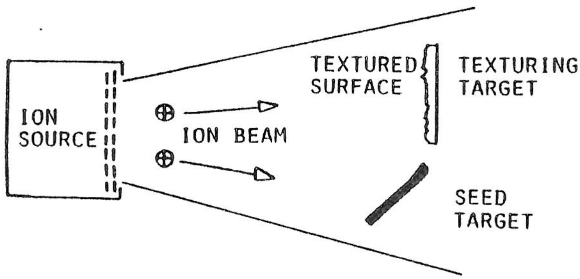

Fig. 1: Principle set-up for texturing

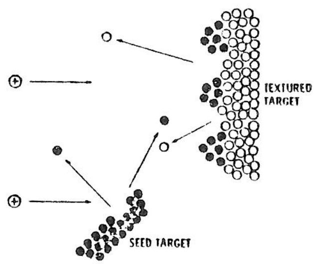

Fig. 2: Basic texturing processes (2)

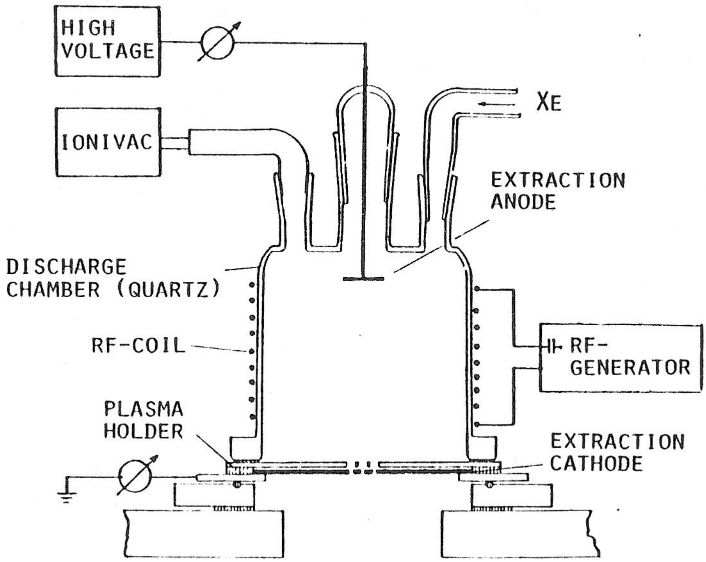

Fig. 3: The rf-ion source for texturing

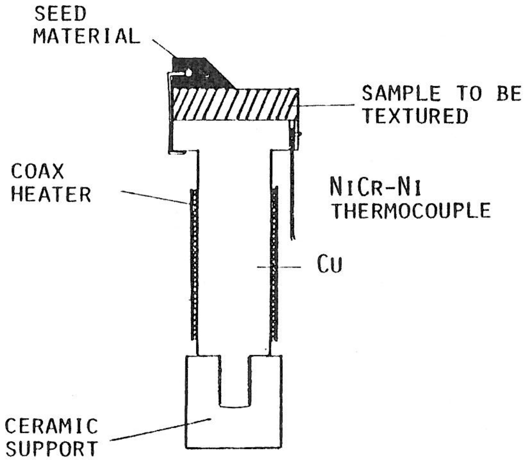

Fig. 4: Sample support for texturing experiments

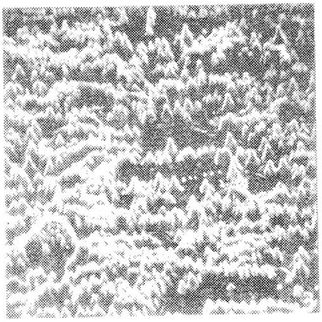

Fig.5: Conical structure of textured Cu (seed material: stainless steel). Magnification: 1800

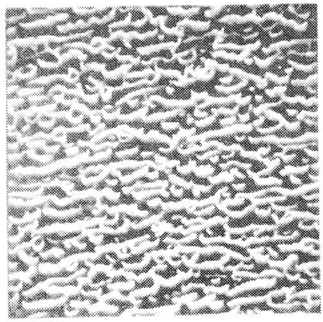

Fig. 6: Ridge-like structure. Stainless steel (seed material: Mo). Magnification: 6500

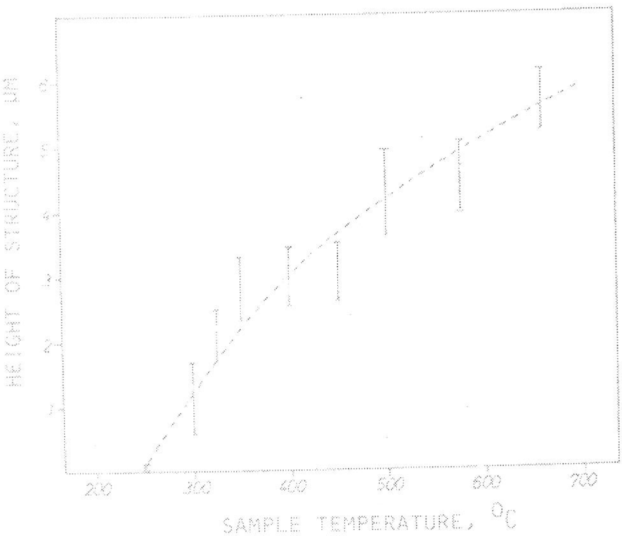

Fig. 7: Increase of the (mean) height of the cones as a function of the sample (Cu) temperature. Critical temperature 250 °C, ion dose 15 mA·min·cm^{-2}

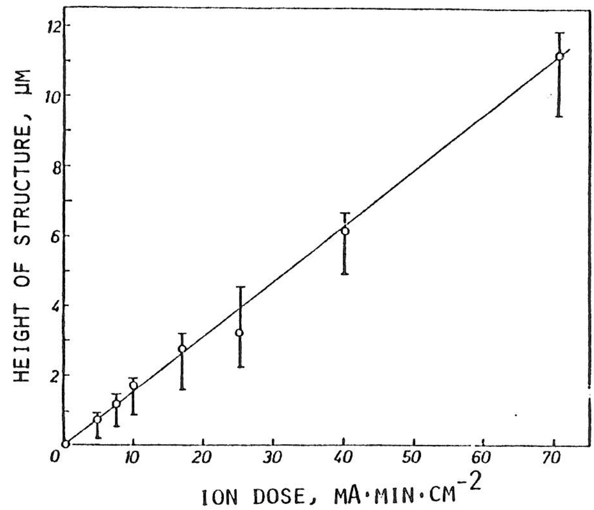

Fig. 8: Height growth of the surface structures (cones) of Cu textured with stainless steel in dependance of the ion dose. Sample temperature 600°C.