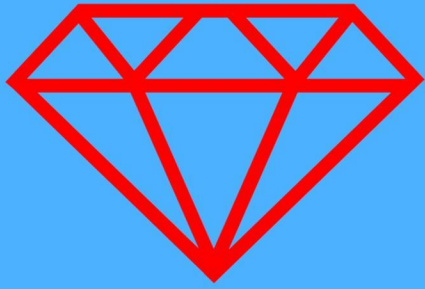


**HEGER**



# **DIAMOND COATINGS**

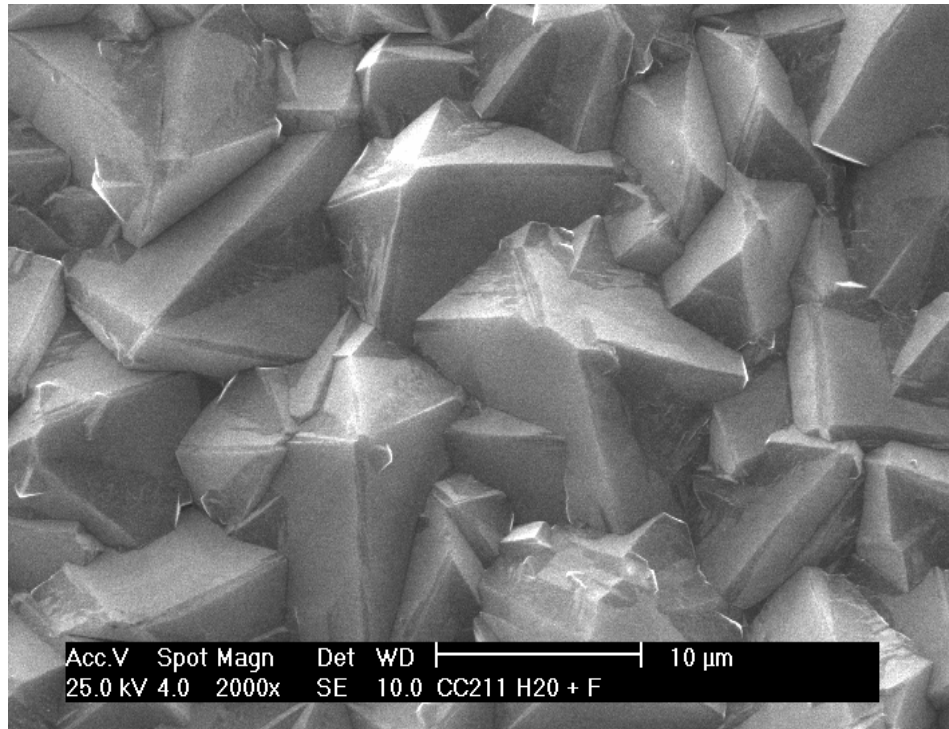
**for mechanical seal faces, nozzles etc.**



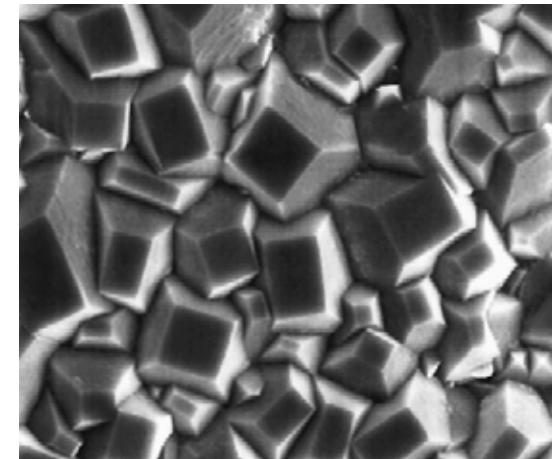
- ◆ **Highest hardness**
- ◆ **Minimal friction**
- ◆ **Minimal wear**
- ◆ **Highest thermal conductivity**
- ◆ **Covalent bond to substrate**
- ◆ **Highly corrosion resistant**
- ◆ **Low lifecycle cost**



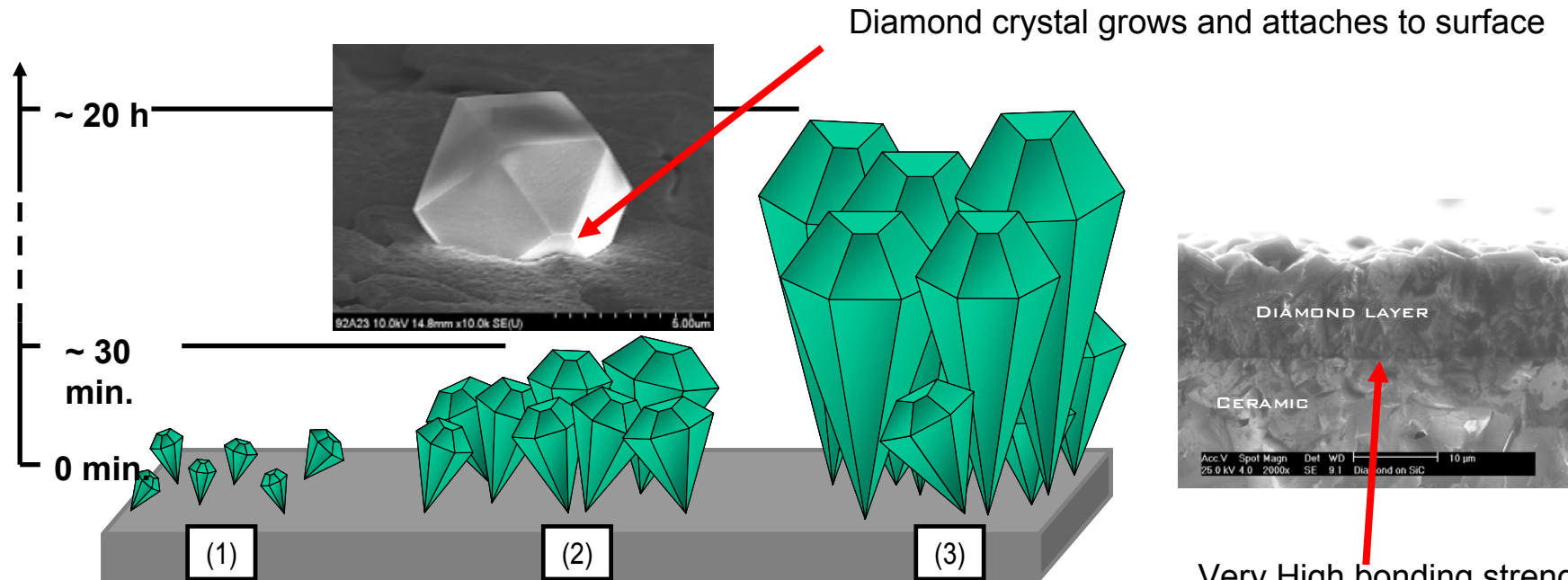
# The Diamond Layer



- Sealed layers after a couple of 100 nm
- High quality Diamond layer
- Layers with different morphologies



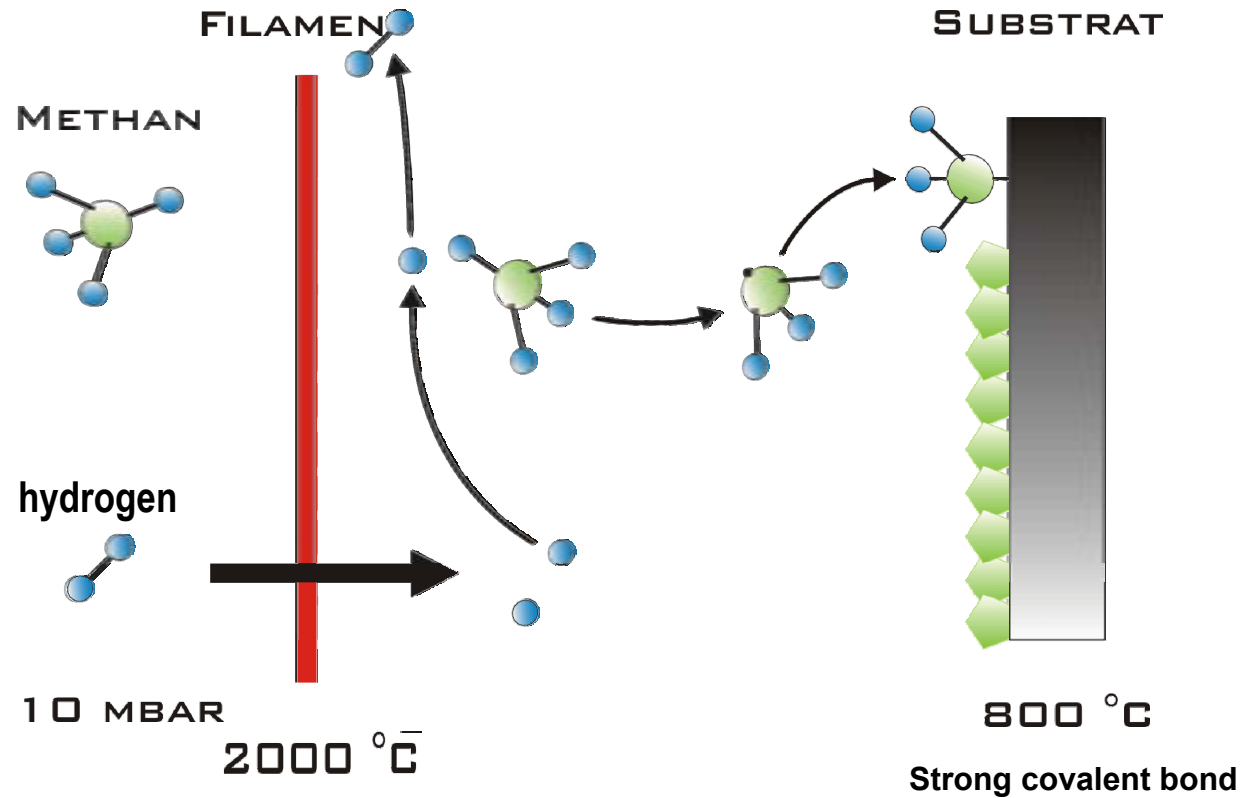
# The Diamond Layer



Very High bonding strength  
due to covalent bond  
because of high coating temperatur

- |                            |                            |                                    |
|----------------------------|----------------------------|------------------------------------|
| - Seeding crystals         | - Diamond layer closing    | - Columnar growth                  |
| - Crystal growth starts    | - Layer thickness ~ 300nm  | - Layer thickness ~ 4µm            |
| - Diamond layer not closed | - Diamond layer not closed | - Process end by standard products |
|                            | - covalent bonding         |                                    |

# The Coating Process



BASEMODEL



## Preparation of Materials

- Cleaning
- Seeding with Crystals



## Diamond Coating

- 5 Hot Filament (HF) Units
- Plasma Unit



P  
R  
O  
D  
U  
C  
T  
I  
O  
N

**Plasma - Unit**  
fast



**HF - Unit**  
experimental



**HF - Unit**  
small series



**HF - Unit**  
production



**2 HF - Units**  
production







# Coatable Materials

	II											III	IV
Li	Be		<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="width: 30px; height: 10px; background-color: #90EE90; border: 1px solid black;"></div> very good coatability (good bonding)  <div style="width: 30px; height: 10px; background-color: #0000FF; border: 1px solid black;"></div> coatable  <div style="width: 30px; height: 10px; background-color: #FF4500; border: 1px solid black;"></div> not coatable (graphit formation) </div>									B	C
Na	Mg											Al	Si
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb
	Ra	Ac											

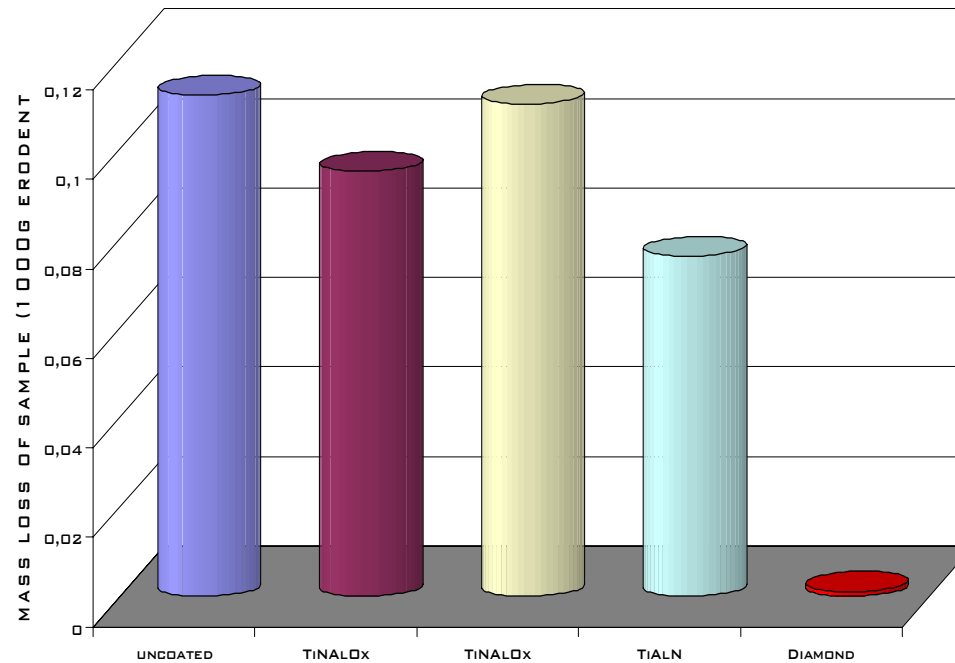
# Comparison

Diamond Coating  
to other coatings



Diamond has highest hardness

Diamond has high resistance to  
three-body wear

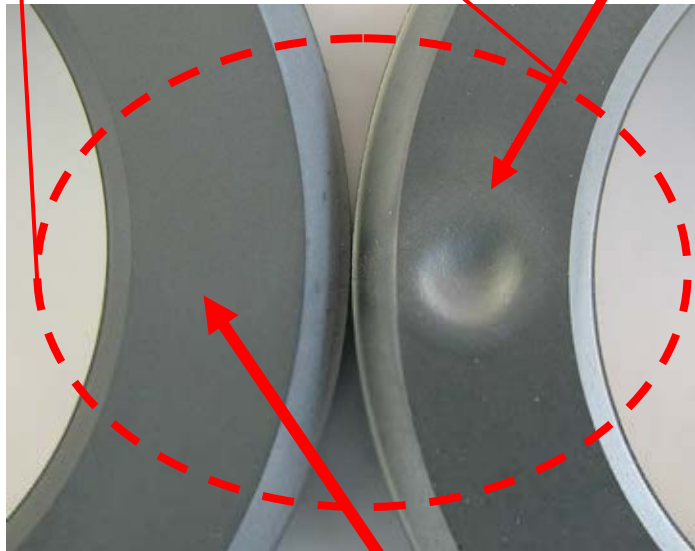


Sandblasting Test of different coatings on Titanium substrate



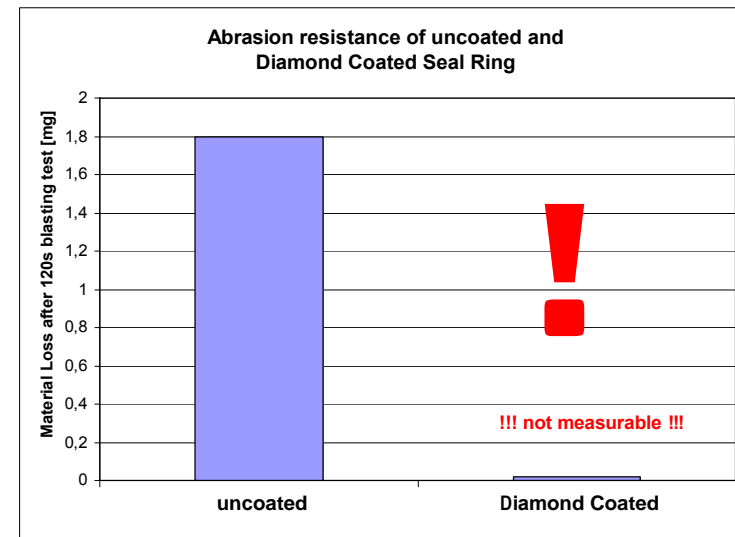
## Blasting Test with abrasive SiC-Particles Particle size 30 $\mu$ m

abrasion indentation due to  
SiC particle bombardement



Diamond Coated

uncoated



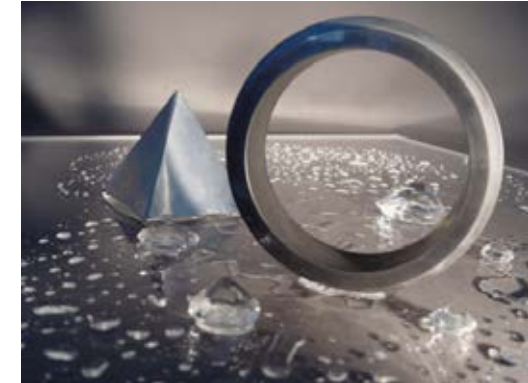
no visual or measurable sign of DAMAGE detectable !



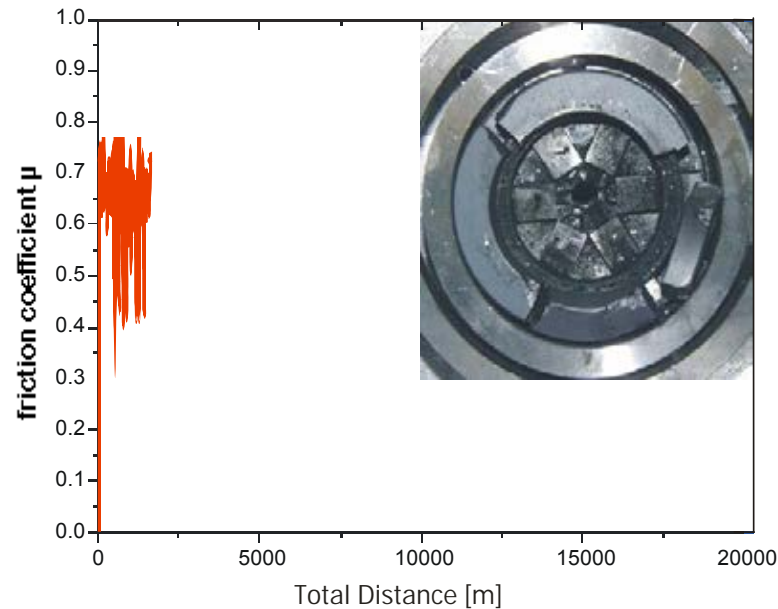
# TRIBOLOGY

## Rings for Seals & Bearings

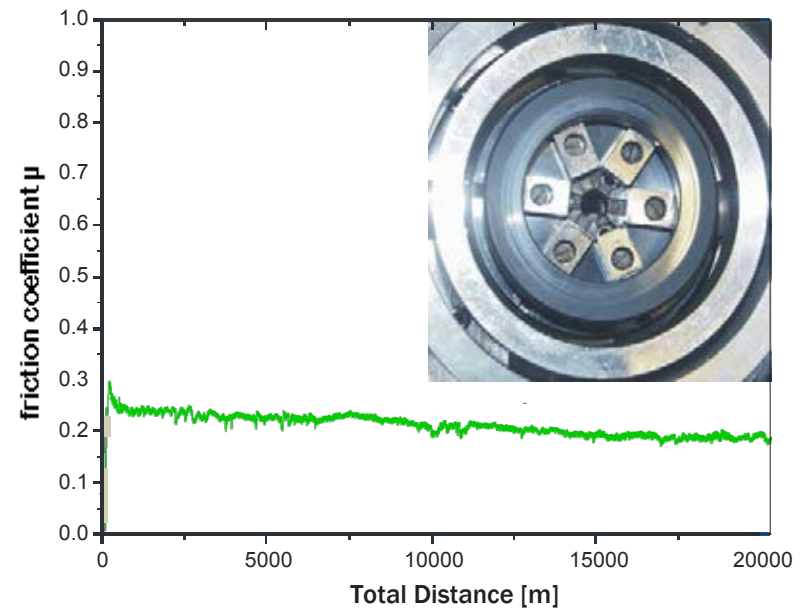
**!!! DRY RUNNING !!!**



**Non-Coated Silicon Carbide**  
Total Loss in Short Time



**Diamond Coated Silicon Carbide**  
extremely long Emergency running



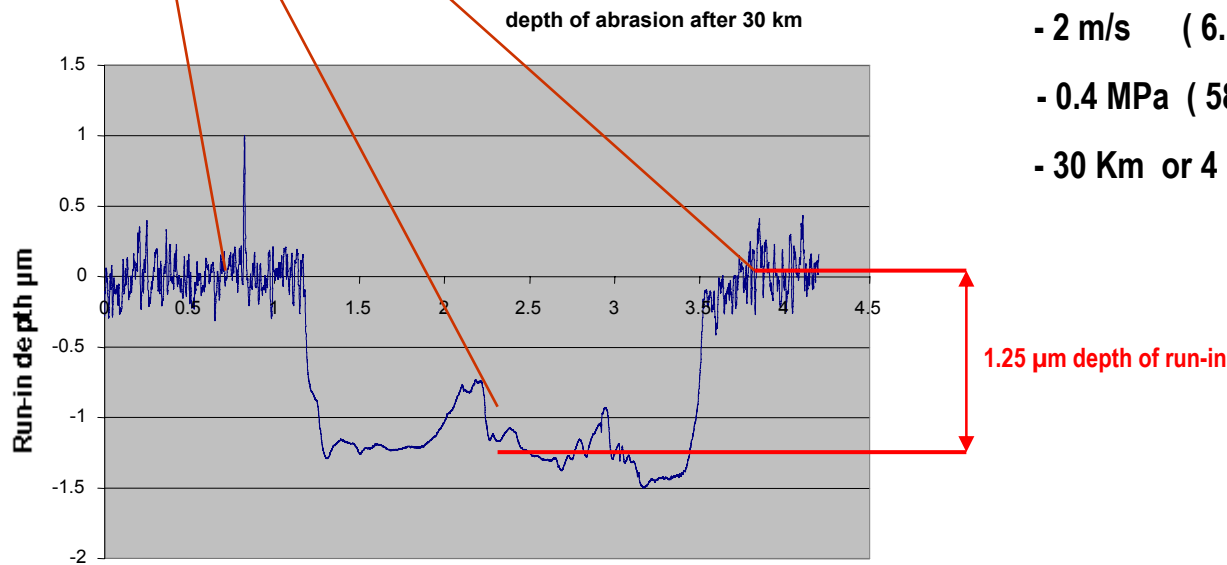


run-in area due to smaller counter ring after 30 Km dry run test

**!!! DRY RUNNING !!!**

Test Parameters:

- 2 m/s ( 6.56 ft/s )
- 0.4 MPa ( 58 psi )
- 30 Km or 4 hours

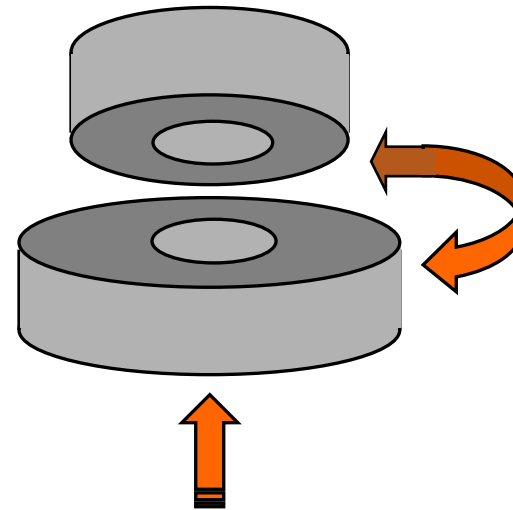


**After 4 hours of dry running only appr. 1.25  $\mu\text{m}$  wear !  
Seal Surface is not destroyed !!!**

Tribometer WAZAU TRM 1000



**!!! DRY RUNNING !!!**



TEST FOR MECHANICAL SEALS

Test Parameters:

- 2 m/s ( 6.56 ft/s )

- 0.4 MPa ( 58 psi )