SHAPE MEMORY POLYMERS-(SMPs) NANOSTRIP MULTILAYERS APPLIED ON THE NEW BEARING GENERATION FOR HARD WEARING IN TURBOCHARGES

Paul Olaru
Honeywell Brno, CZECH Rep
Ian Hutchings
IfM- Univ. of CAMBRIDGE, UK
Nicole Dorr
AC²T-Wr.Neustadt, AUSTRIA

"I wish like in our country to be fewer lawyers and more engineers!"

Mr. Barack Obama,

USA President

Introduction

Shape memory polymers-(SMPs) ,represent co-polymers which generally the structure consists of two type of components(Figure.1). One component,like nanostrip multilayers, with the higher glass transition or melting temperature, represent the hard component. This hard component (elastomer) represent the main element of SMPs, which improve the tribological (wearing resistance) properties and provides the mechanical strength of SMPs at high temperature, T_{trans}, where the soft component (thermoplast), which stabilizes the hard component at low temperature , looses its strength. Compared to metallic shape memory alloys, SMPs, have the ability to store and recover larger strains (up to more than 200%). They are cheap, light in weight, non-toxic, and easy to process. The most important is capacity to be biocompatible and biodegradable. These properties and characteristics offer to SMPs nanostrip multilayers, like one potential candidate for future bearings in turbochargers. This work describes the investigation Tribology Laboratories, IfM- Univ. of Cambridge-UK, and D8 DISCOVER with GADDS -BRUKER AXS – Germany

Experimental Results

Shape memory polymers-(SMPs) nanostrip multilayers, show a new challange effect vs. shape memory alloys (SMAs). Its can be deformed into a new shape and recover to a programmed permanent shape by heating . The SMPs effect of polymers can be established in different classes of polymers like: polyethylene, polyurethanes[and biodegradable, SMPs based on polycaprolactone. In the present work we show SMPs nanostrip multilayers experiments and results on the nanostrip multilayers sample of the ***Vybormem-SMP*****,** (Figure 1), which is compared with NiTi-shape memory alloys,and special stress measurements by diffraction system D8 DISCOVER with GADDS .

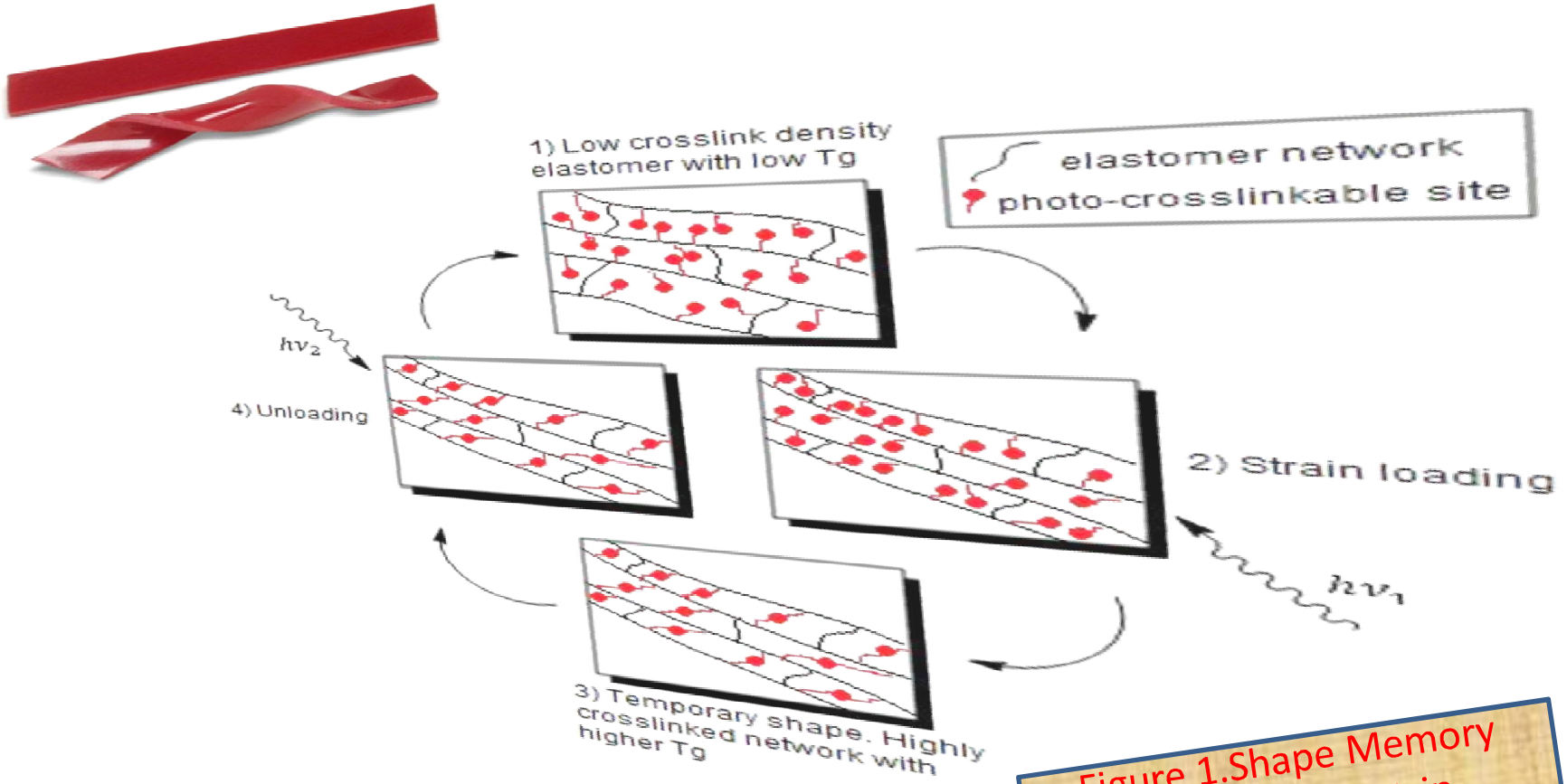

Figure 1.Shape Memory Polymer nanostrip multilayers-Vybormem

Table 1. The Comparison Shape Memory Polymer-SMP, **Vybormem** vs. Shape Memory Alloys

Parameters	**Shape Memory Polymer- SMP Vybormem**	**Shape Memory Alloys- NiTiX [6]**
Density, g/cm³	**0,8-1,2**	**6,3-6,7**
Deformation, %	**Up to 237**	**8**
Young modulus T Ttrans, GPa	**0,0088-1,0**	**72-98**
Tensile strength, Yield, MPa	**19,0**	**27,0**
Temperature work , ºC	**(-15) / (+310)**	**(-50) /(+100)**
Thermal conductivity, W/mK	**0,12-0,35**	**12-18**
Biocompatibility/degradability	**Can be biocompatible and / or biodegradable**	**Good biocompatible and not biodegradable**
Processing conditions	**Low pressure, 250ºC**	**High pressure, 1000ºC**
Corrosion resistance	**Excellent**	**Very good**
Costs	**185€/kg**	**300-360€/kg**
Hardness, Shore A	**75**	**50-64**
Compression set	**72 hours @ 200ºC**	**-**

Figure 2. Shape Memory Polymer-SMP, Vybormem : the nanostrip dimensions: 5 x 25 x 125 nm; Presentation of the Shape Memory Polymer after 25 tests , max. strain 100%

Figure 3. Effect of the glass transition

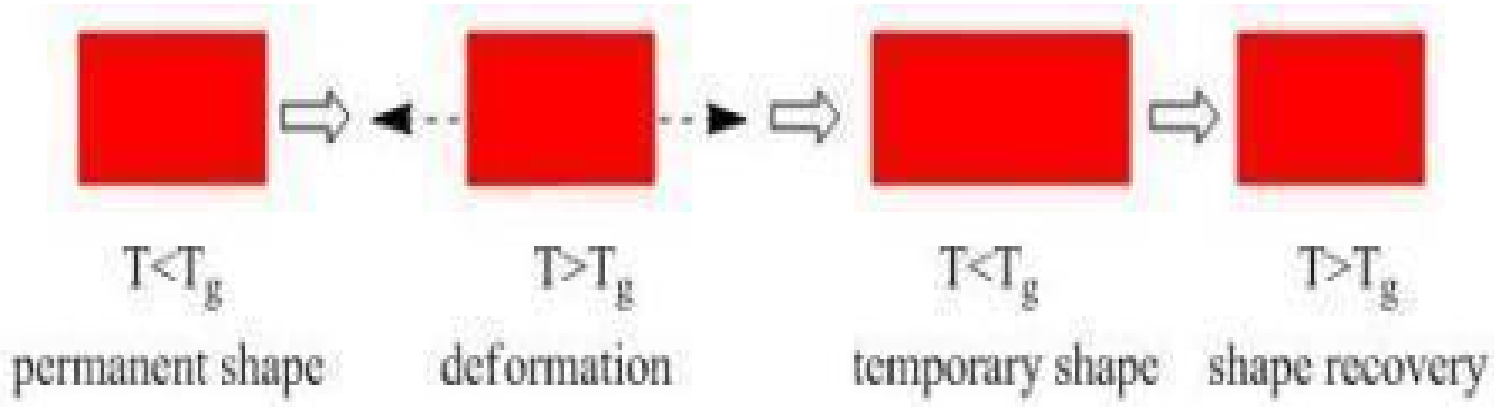

Figure 4. Electrical / Friction vs. Temperature for Shape Memory Polymer-SMP, Vybormem :

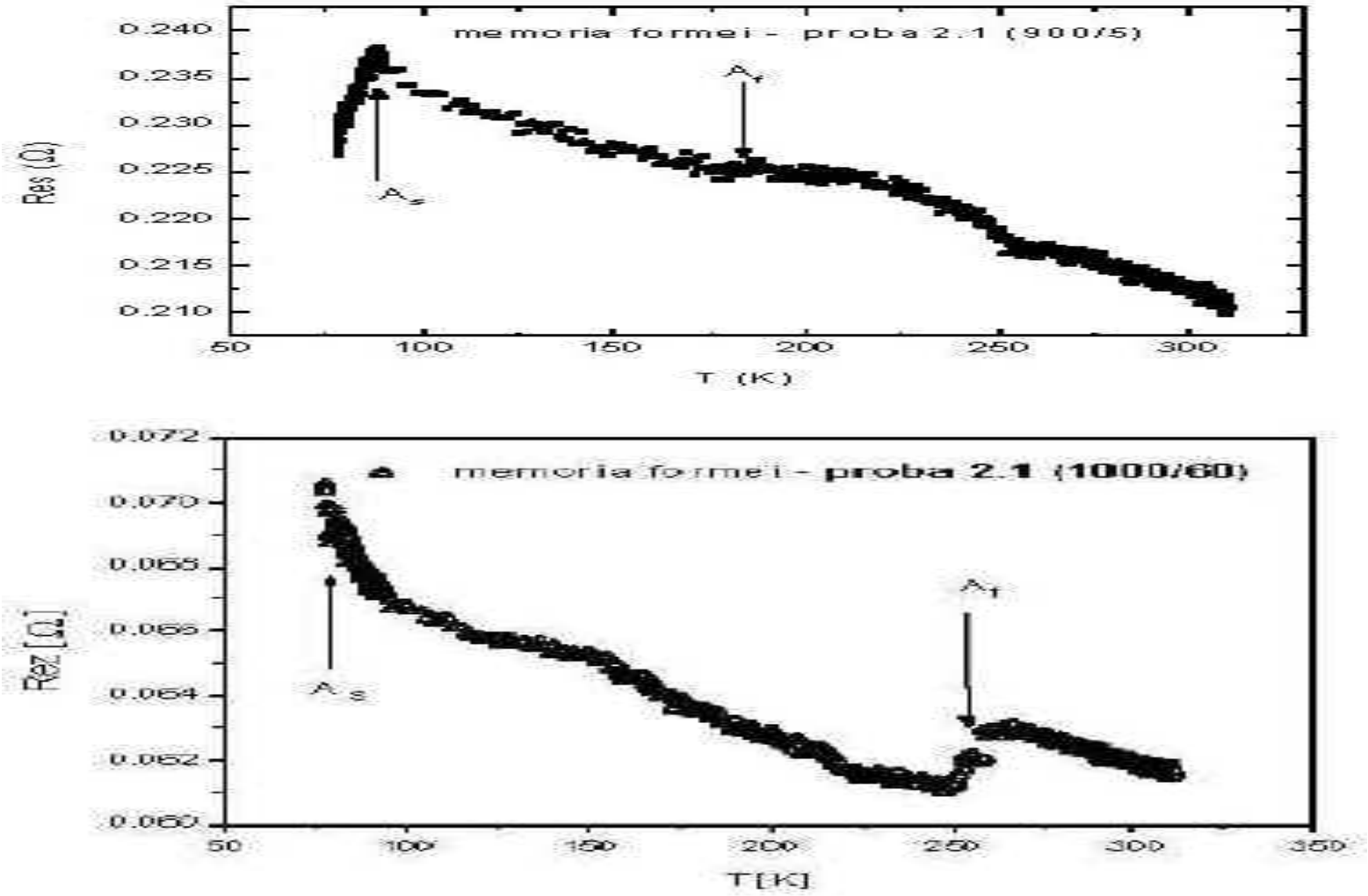

Figure 5. Shape Memory Polymer-SMP, Vybormem nanostrip spot front size , low zoom (up), and spot-size front size, high zoom (down) ;

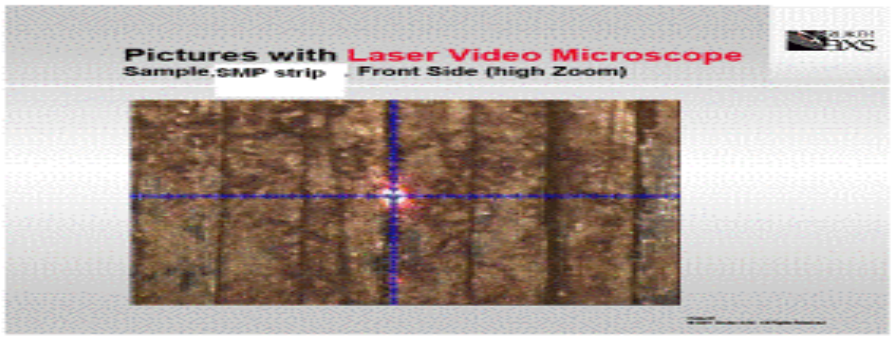

Figure 6. Shape Memory Effect of Shape Memory Polymer- Nanostrip Multilayer's , SMP, Vybormem over 46ºC ;

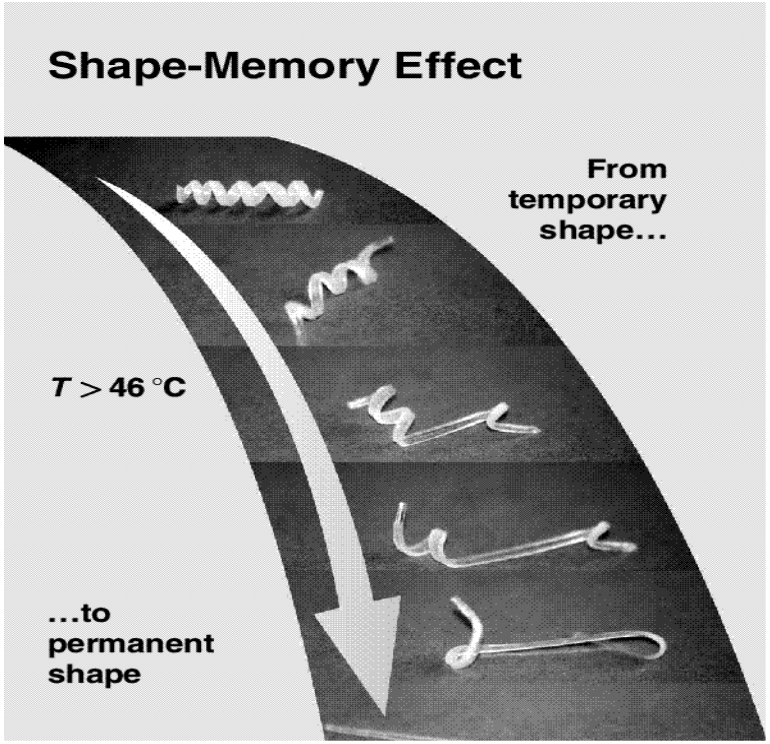

Figure 7. Shape Memory Polymer-SMP nanostrip multilayer's, Vybormem application on the Bearing O-Ring ;

Figure 7a. SMPs nanostrip multilayer's covering O-Ring used in bearing turbocharger

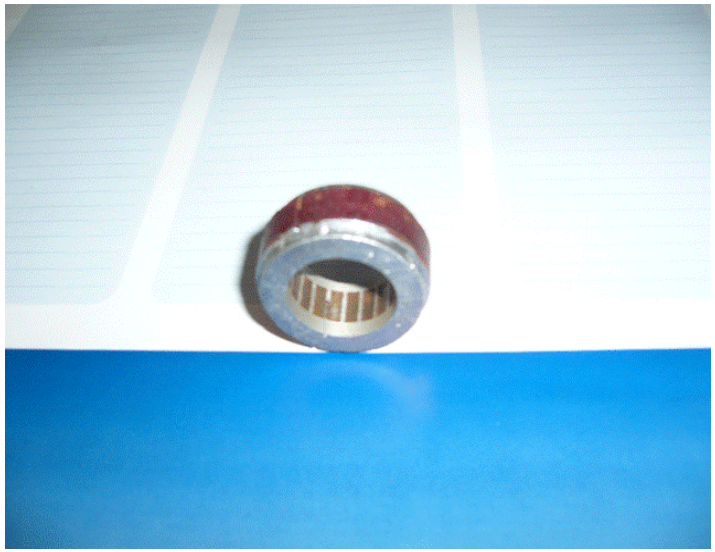

Figure 7b. SMPs nanostrip multilayer's covering O- Ring used in the bearing turbocharger after one full test

Thank you for your attendance !