



HAL
open science

Plastic deformation of Na-aluminosilicate glasses under micro and nano-indentation

Vera Pukhkaya, Jérémie Teisseire, Manon Heili, Christine Martinet, Valérie Martinez, Bernard Champagnon, Guillaume Kermouche, Etienne Barthel

► **To cite this version:**

Vera Pukhkaya, Jérémie Teisseire, Manon Heili, Christine Martinet, Valérie Martinez, et al.. Plastic deformation of Na-aluminosilicate glasses under micro and nano-indentation. CFM 2015 - 22ème Congrès Français de Mécanique, Aug 2015, Lyon, France. hal-03444598

HAL Id: hal-03444598

<https://hal.science/hal-03444598>

Submitted on 23 Nov 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Plastic deformation of Na-aluminosilicate glasses under micro and nano-indentation

V. Pukhkaya^a, J. Teisseire^a, M. Heili^b, C. Martinet^b, V. Martinez^b,
B. Champagnon^b, G. Kermouche^c, E. Barthel^d

a. Surface du Verre et Interface, Saint-Gobain Recherche, 93303, Aubervilliers, France
vera.pukhkaya@saint-gobain.com, jeremie.teisseire@saint-gobain.com

b Institut Lumière Matière, UMR5306 CNRS, 69622, Villeurbanne, France
manon.heili@univ-lyon1.fr, christine.martinet@univ-lyon1.fr, valerie.martinez@univ-lyon1.fr,
bernard.champagnon@univ-lyon1.fr

c Ecole des Mines de Saint-Etienne, Science of Materials and Structures (SMS) Division,
CNRS, 42023, Saint-Etienne, France kermouche@emse.fr

d Ecole Supérieure de Physique et de Chimie Industrielles de la Ville de Paris (ESPCI)
ParisTech, PSL Research University, Sciences et Ingénierie de la Matière Molle,
CNRS UMR 7615, 10, Rue Vauquelin, F-75231 Paris Cedex 05, France
and

Sorbonne-Universités, UPMC Univ. Paris 06, SIMM, 10, rue Vauquelin, F-75231
Paris Cedex 05, France etienne.barthel@espci.fr

Résumé:

The transition « normal glass – anomalous glass » is followed on Na-aluminosilicate glass model system using micro- and nano-indentation investigation.

Mots clefs : Silicate glasses, Plasticity, Indentation

1 Introduction

Under micro-indentation, silica and silica-based glasses exhibit plastic response at the micrometer scale. Due to the small size, it is difficult to characterize the plastic deformation of amorphous material. Previously we have quantified the densification of silica after indentation with Raman spectroscopy [1], and derived a constitutive law for plastic deformation [2]. This phenomenon of densification (or compaction) is typical for anomalous glasses. It is in contrast to normal glasses such as window (or float) glass which densifies relatively little, but generates shear bands. Here we report on our efforts to study the impact of composition on the plastic response of glasses, and especially investigate the difference between normal and anomalous glasses under indentation. Na-aluminosilicate glasses have been chosen as system model. The degree of polymerization is varied through the Al/Na ratio.

2 Results

We used diffused composition gradients to evaluate individual Raman partial spectra as a basis for the investigation of structure. The glass compositions were controlled by μ -probe analysis, the moduli and hardness measured by Berkovich nano-indentation along all the series of diffused glass. Evolution of nano-indenters' shape has been followed by Atomic Force Microscopy. We reveal the influence of glass polymerization on its elastic response under nano-indentation and the nano-indenters' shape.

To study the impact of plastic deformation on the glass structure, we used 2 kg Vickers indents and mapped the Raman signal. The Raman maps have been obtained at the surface x - y surface (Figure 1) as well as inside the sample, as cross-sections. We used the evolution of the Si-O-Si(Al) vibrational mode in the $300\text{-}730\text{ cm}^{-1}$ region to evaluate the residual plastic strain.

