Experimental and theoretical investigations of friction properties of graphite intercalated compounds.

Jean-Louis Mansot, Karl Delbe, Philippe Baranek, Philippe Thomas, Florent Boucher, Rene Vangelisti, Denis Billaud

▶ **To cite this version:**

Jean-Louis Mansot, Karl Delbe, Philippe Baranek, Philippe Thomas, Florent Boucher, et al.. Experimental and theoretical investigations of friction properties of graphite intercalated compounds.. 40th Leeds-Lyon Symposium on Tribology & Tribochemistry Forum 2013, Sep 2013, Lyon, France. hal-00926509

HAL Id: hal-00926509
https://hal.science/hal-00926509

Submitted on 9 Jan 2014

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.

Open Archive Toulouse Archive Ouverte (OATAO)

OATAO is an open access repository that collects the work of Toulouse researchers and makes it freely available over the web where possible.

This is an author-deposited version published in: http://oatao.univ-toulouse.fr/
Eprints ID: 9781

To cite this version:

Mansot, Jean-Louis and Delbe, Karl and Baranek, Philippe and Thomas, Philippe and Boucher, Florent and Vangelisti, Rene and Billaud, Denis *Experimental and theoretical investigations of friction properties of graphite intercalated compounds.* (2013) In: 40th Leeds-Lyon Symposium on Tribology & Tribochemistry Forum 2013, 04 September 2013 - 06 September 2013 (Lyon, France).

Any correspondence concerning this service should be sent to the repository administrator: staff-oatao@listes-diff.inp-toulouse.fr

Experimental and theoretical investigations of friction properties of graphite intercalated compounds.

J.L.Mansot[1,2]*, K. Delbé[3], P. Baranek[4], P. Thomas[1], F. Boucher[5], F. Vangelisti[6], D. Billaud[6].

[1)] Groupe de Technologie des Surfaces et Interfaces (GTSI EA 2432) Université des Antilles et de la Guyane,

[2)] Centre Commun de Caractérisation des Matériaux des Antilles et de la Guyane (C^3MAG), Université des Antilles et de la Guyane Campus de Fouillole, BP 250 97157Pointe à Pitre, Guadeloupe, F.W.I

[3)]LaboratoireGénie de Production, EA 1905, ÉcoleNationaled'Ingénieurs de Tarbes, BP 1629, 65016, TarbesCédex

[4)] EDF - R&D, Department MMC and MAI, Avenue des Renardières, Les Renardières, 77818 Moret sur Loing Cedex

[5)] Laboratoire de Chimie des Solides, Institut des Matériaux Jean Rouxel, UMR 6502 CNRS-Université de Nantes, 2 rue de la Houssinière, BP 32229, 44322, NantesCédex 3, France

[6)]Institut Jean Lamour, UMR CNRS 7555, Faculté des Sciences, Université Henri Poincaré Nancy I, BP 239, 54506 Vandoeuvre-Lès-NancyCédex, France

*Corresponding authorjean-louis.mansot@univ-ag.fr

1. Introduction

It is classically admitted that the goodfriction properties of lamellar compounds are strongly related to their anisotropic structure and especially to the existence of weak interlayer interactions through the van der Waals gap separating the basal layers [1]. As it is also known, the presence of the van der Waals gap in the structure of lamellar compounds will allow lot of chemical species to be intercalated in the structure leading both to the expansion of structure parameters and inter layer interactions modifications [2]. The present work is concerned with the experimental and theoretical study of friction propertiesof Graphite Intercalated Compounds (GICs) in order to better understand thetribologiclamellar compounds. In order to modulate the interlayer interactions, two types of intercalated species were used, electrophylic species ($AlCl_3$, $FeCl_3$, $SbCl_5$) and nucleophilic species (Li, K, Rb).

2. Experimental and theoretical method

Friction properties were studied using a reciprocal sphere/plane (AISI52100/AISI52100) tribometer under pure argon atmosphere. The electronic properties and interlayer interactions were investigated using ab initio band structure calculations based on DFT theory [3].

3. Results and discussion

Tribologic results collected on the various GICs are presented in figure1.

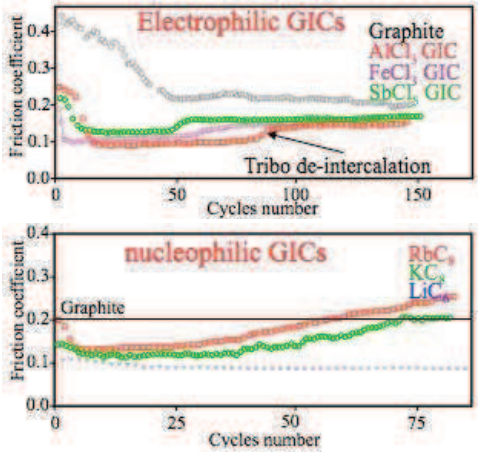

Figure 1: Evolution of friction coefficients as a function of cycles number for the two GICs families.

As it can be seen, the various GICs compounds present better intrinsic friction coefficient (measured in the early stage of friction tests) than graphite. Most of the compoundspresents a de-intercalation process during sliding leading to an increase of the friction coefficient as a function of cycles number.

The figure 2 presents the evolution of the intrinsic friction coefficient as a function of the calculated interlayer interaction intensities.

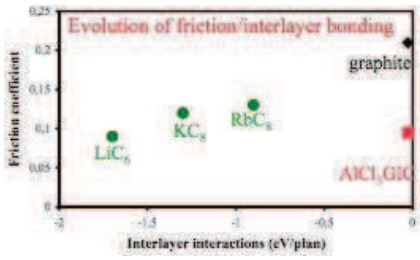

Figure 2: Friction coefficient as a function of the calculated interlayer interaction intensities.

As expected electrophilic intercalated GICs, which present low intrinsic friction, also present low interlayers interactions (lower than graphite) according to the classical interpretation of tribologic properties of lamellar compounds. The very high interlayer interactions in the case of the nucleophilicGICs associated also with friction coefficient lower than graphite is surprising. It demonstrates that friction properties are not simply related to interlayer interactions but also to other parameters such as the mobility, in the van der Waals gap, of the intercalated species. This last hypothesis is strongly suggested by the friction coefficient increase recorded from Li to Rb ions.

4. References

[1] Nanolubricants, J.M. Martin and N. Ohmae ed., J. Wiley and Sons, New-York, (2008).

[2] Dresselhaus, M.S., Dresselhaus, G., Intercalation compounds of graphite, Advances in Physics, 51, 2002, 1-186.

[3] Delbé, K., Mansot, J.-L., Thomas, Ph., Baranek, Ph., Boucher, F., Vangelisti, R., Billaud, D., Contribution to the understanding of tribological properties of graphite intercalation compounds with metal chloride,Tribology Letters, Volume 47, Issue 3, 2012, 367-379.