

HYBRIDS OF IONIC LIQUIDS AND CU-DECORATED CARBON NANOTUBES AS POTENTIAL SUPERLUBRICANTS FOR STEEL-POLYMER FRICTION PAIRS

Ł. Wojciechowski ^{a*}, K.J. Kubiak ^b, S. Boncel ^c, M. Skrzypek ^a, B. Gapiński ^d, A. Marek ^c,
S. Ruczka ^c, R. Jędrzyak ^c, P. Błaszkiwicz ^e, J. Kałużny ^a, T.G. Mathia ^f

*Lukasz.Wojciechowski@put.poznan.pl

^a Poznan University of Technology, Faculty of Civil and Transport Engineering, ul. Piotrowo 3, 60-965, Poznan, Poland

^b University of Leeds, School of Mechanical Engineering, Leeds, LS2 9JT, United Kingdom

^c Silesian University of Technology, Faculty of Chemistry, ul. Ks. M. Strzody 9, 44-100, Gliwice, Poland

^d Poznan University of Technology, Faculty of Mechanical Engineering, ul. Piotrowo 3, 60-965, Poznan, Poland

^e Poznan University of Technology, Faculty of Materials Engineering & Technical Physics, ul. Piotrowo 3, 60-965, Poznan, Poland

^f Laboratoire de Tribologie et Dynamique des Systèmes (LTDS) - C.N.R.S., École Centrale de Lyon, 36 avenue Guy de Collongue, 69134 Écully Cedex, France, France

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ABSTRACT

Frictional losses lead to significant energy waste in many practical applications. To reduce this waste, tribologists aim to minimize movement resistance by achieving superlubricity with a coefficient of friction lower than 0.01. In our previous research [1], we discovered that applying a hybrid lubricant consisting of an ionic liquid (IL, as the liquid phase) and Cu-decorated multi-wall carbon nanotubes (MWCNTs, as a tribo-active thickener) can help achieve the effect of superlubricity for polymer-steel friction pairs. However, this condition was only observed in the initial phase of the test, under low load and for a short time. Therefore, in this research, we focused solely on the frictional behavior of a polymer-steel contact lubricated with an ionic liquid-based lubricant that incorporates Cu-decorated CNTs.

Trihexyltetradecylphosphonium bis(2-ethylhexyl) phosphate ($C_{48}H_{102}O_4P_2$) was used as a liquid phase to form a hybrid lubricant. Cu-decorated MWCNTs were added at concentrations of 0.1%, 0.5%, 0.75%, and 1% wt. As a reference for the hybrid lubricants, a commercial polyalphaolefin grease dedicated to polymers with a polyurea thickener and pure IL were applied. All lubricants were used to lubricate the polymer-steel friction pair in the 'block-on-ring' tribological tests under different loads (250, 500, 750 and 1000 N). Two commonly applied in tribology polymers: PA-6, and UHMWPE were used as blocks in the tests. All the ring counterparts were made of AISI 4130, and an identical configuration was kept for all the polymers. Worn surfaces of polymers were analysed using SEM, EDS, topography, SFE, and wettability measurements, before and after the tests. This allowed the identification of friction and wear mechanisms and the correlation of some parameters of the surface condition with the results of tribological tests. The addition of Cu-decorated CNTs had a beneficial effect on both polymers' COF and wear, as shown in Fig. 1 (an example of PA

lubricated with IL + Cu-CNTs 0.1%). In the case of the lowest load, a COF of approx. 0.008 was obtained for three contents of the additive: 0.1, 0.5, and 0.75% wt.

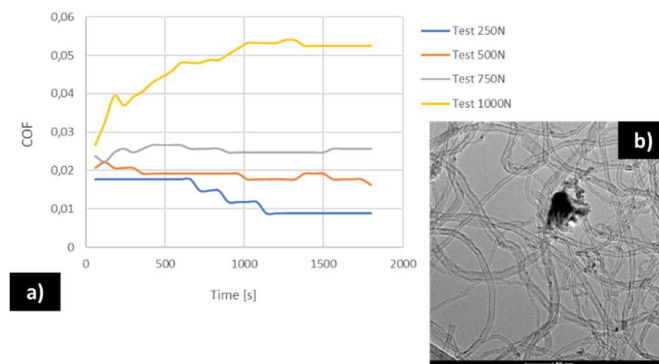


Fig.1 Average COF trends (PA-AISI4130) lubricated with IL+0.1% Cu-CNT for different test loads (a), TEM image of Cu-decorated CNTs (b).

For higher loads, the beneficial effect of Cu-CNT (0.1-0.75% wt.) on COF (PA-AISI4130) is still observable, however its value is higher than 0.01. For the second material pair (UHMWPE-AISI4130), the superlubricity effect was not achieved. However, the addition of Cu-CNT ensured very stable operation for all loads in the still favourable COF range, from 0.015 (250 N) to 0.029 (1000 N).

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