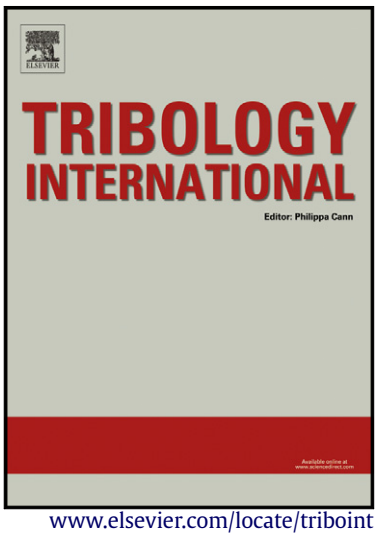

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www.elsevier.com/locate/triboint

PII: S0301-679X(14)00216-3
DOI: http://dx.doi.org/10.1016/j.triboint.2014.05.028
Reference: JTRI3351

To appear in: *Tribology International*

Received date: 18 June 2013
Revised date: 4 May 2014
Accepted date: 7 May 2014

Cite this article as: M.T. Fowell, C. Myant, H.A. Spikes, A. Kadiric, A study of lubricant film thickness in compliant Contacts of elastomeric seal Materials using A laser induced fluorescence technique, *Tribology International,* http://dx.doi.org/10.1016/j.triboint.2014.05.028

A Study of Lubricant Film Thickness in Compliant Contacts of Elastomeric Seal Materials Using a Laser Induced Fluorescence Technique

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Abstract

A laser induced fluorescence technique was used to investigate the build-up of lubricant films in compliant contacts operating in the isoviscous elasto-hydrodynamic regime (I-EHL). The described technique utilises an optimised optical set-up with a relatively high signal-to-noise ratio and was shown to be able to produce film thickness maps of the complete contact area and measure a very wide span of thicknesses, from 50 nm to 100 μm. Maps of film thickness were obtained over a range of entrainment speeds and loads for three different contact configurations and two elastomer materials, polydimethylsiloxane (PDMS) and a fluorocarbon rubber (FKM) which is typically used in rotary seal applications. In a model contact of a nominally smooth PDMS ball sliding on a glass flat, a crescent shaped area of reduced film thickness was observed towards the contact exit. In contrast to typical elasto-hydrodynamic contacts, no side-lobes of reduced film thickness were recorded, while the central film region exhibited a converging wedge shape. The elliptical contact of an FKM O-ring rolling on a glass flat showed a central region of flat film while areas of minimum film thickness were located near the contact edges either side of the centre. The highly conformal contact of relatively rough FKM O-ring sliding against a concave glass lens, a geometry more representative of that found in elastomeric seals, showed discrete regions of reduced film, corresponding to surface roughness asperities. With rising entrainment speed, some lift-off was observed, with surface roughness asperities appearing to be increasingly compressed. Measured films thicknesses were compared to existing theoretical predictions for I-EHL contacts and the level of agreement was found to be highly dependent on contact geometry and applied conditions.

Keywords: Seals, Elastomers, Compliant Contacts, Film thickness, Rolling Bearings, Isoviscous, EHL, LIF, Fluorescence

1 Nomenclature

a	Contact semi width in x plane (m)	h_m	Minimum film thickness (m)
b	Contact semi width in y plane (m)	h_o	Outlet film thickness (m)
h_c	Central Film Thickness (m)	k	Ellipticity parameter (a/b)
h_i	Inlet film thickness (m)	r_{x1}	Radius of body 1 in x plane (m)