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Discussion: "Modeling of Flash Temperature for Elastic Sliding Contact of Single Micro-Asperity Pair" (Wu, Z., Zhang, Y., Xu, Y., Jie, D., and Jackson, R. L., 2024, ASME J. Tribol., 146(1), p. 011702)

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Reflecting on the application and implications of this work [1], the authors realized that a few items should be discussed.

Although the work is for elastic sliding contact, it could be adapted for elastic–plastic contact by employing an existing sliding elasto-plastic model [2,3]. These models are slightly different but originated at the same time. The paper by Jackson et al. provides equations to predict the tangential and normal forces during an elastic–plastic sliding. The model by Green [2] is based on a strain energy balance and is calibrated to finite element results found in a thesis by Moody [4]. It might be possible to adjust the factor given by Eq. (11) in the paper [1] for a maximum pressure predicted by these works. The maximum pressure for an elastic–plastic model will likely be lower than the elastic case, and the flash temperature will also be lower. Perhaps, the plastic deformation of asperities could effectively limit the magnitude of the flash temperature.

Looking at the asperity scale, which this calculation is likely to be implemented for, the size of an asperity can vary in size by many orders of magnitude. Some asperities will be on the nanoscale and therefore molecular models might provide additional insight. For instance, in the work by Vadgama et al. considered a molecular dynamics model of a sliding interference between two copper asperities [5]. As the asperities interfere the temperature rose by 100's of Kelvin. Zhang et al. [6] studied the sliding contact of a hemispherical silicon carbide asperity pair, and found there is no clear relationship between forces and lattice orientation for silicon carbide when compared with Vadgama et al.'s work. However, these molecular models are also quite different from this case because they also include plasticity, adhesion, and effective friction between the surfaces. In addition, in a molecular dynamics model, a thermostat technique is often used that could eliminate or lessen the observed flash temperature.

In addition, with high temperatures, the yield strength of the contact materials will decrease (i.e., thermal softening). If the temperature reaches the melting point of the material, then the yield strength effectively becomes nil [7]. This is effectively included in the molecular dynamics models previously mentioned. In molecular models, the temperature is atomic vibration that allows plastic displacement of atoms to occur under less force. This effect will result in the increase of plastic deformation and lowering of the flash temperature, which also appears to be indicated by this recent work that uses a meshless continuum mechanics model [8].

The next step of these types of models would be to predict the flash temperature of a rough surface with multiple asperities in contact. Based on Green's function, Vick and Furey [9] and Coulibaly et al. [10] studied the calculating of temperature rises due to multiple, interacting contacts when a set of regularly arranged rectangular asperities sliding against a plane surface. Choudhry et al. [11] formulated a multiscale model of fractal surfaces that predicted the flash temperatures on asperities of different sizes. This work [11] also included the influence of wear which can effectively limit the magnitude of the flash temperature rise. However, it was modeled as a rough surface loaded against a flat surface and so did not address the asperity against asperity contact considered by the current work [1].

In rough surface contact with sliding, it will also almost always be true that the surfaces change over time due to deformation and wear. Therefore, the geometry of the asperities will change and the flash temperatures will as well. In some moderately higher temperature conditions, the asperities on the surface will be smoothed out [12]. In more severe conditions, this could lead to thermo-elastic instabilities [13–15] and scuffing [16], where the surfaces often appear to be smeared [17] and could lead to welding of the surfaces. In summary, the flash temperature of sliding rough surfaces could in some conditions lead to a smoothing and perhaps improved performance, and in other conditions, a thermally induced failure. The current work [1] could help to improve these types of predictions, all there is still much additional work required.

Conflict of Interest

There are no conflicts of interest.

Data Availability Statement

No data, models, or code were generated or used for this paper.

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