Responses to the comments

Dear editors and referees,

We are grateful for the positive and helpful comments by reviewers. Based on the comments we have papered a revised version of the manuscript which will hopefully clarify the remaining questions. Words are highlighted with red in the revised manuscript. Please find our details answers. Thank you very much!

In this section, the answers to the comments are marked with red color.

In the presented work, the authors corrected most of the reviewer's comments. However, one question still remains unanswered. Solving contact issues requires a very careful approach and experience in FEM calculations. The authors improved the model and the obtained results differ significantly from those presented in the previous version. There is some concern that this was left without comment in the response. The problem that remains to be solved is the depicted generation of cracks. The authors ignore this fact. In such a complex model, the way in which cracks are considered and how they affect the contact surface is very interesting. This can be seen in the presented figures 6 and 7. I would like to ask you to present a broader analysis of this problem, because it is very interesting, especially from the point of view of the cracking mechanics of composite coatings.

The more discussions are presented as follows.

The deformation of the MoS_2/Ta coating, VN coating and the SiC coating at the normal direction is 0.2751 μm, 0.1750 μm and 0.1283 μm, respectively. There are many wrinkles presented on the surface of the MoS_2/Ta coating. The deformation of VN coating and the SiC coating looks like five-pointed star and quadrangular star, respectively. The contact style of the frictional pair is the point to surface. It is found that a small circle point appears in all pictures of Fig. 6 and Fig. 7. The top layer coating is sheared by the reciprocating frictional ball. These wrinkles and cracks are generated due to the big normal force and shear force from the moving ball. However, the VN coating and SiC coating bear the normal force mainly. The tiny shear force is just from the local deformation of the MoS_2/Ta coating. The coating collapses around the contact point under the normal force. Thus, the deformation looks like a star. What is more, these three coatings have support actions. The deformation of the C/C substrate shown in Fig. 7(b) is better than that of the SiC coating shown in Fig. 6(f), and the deformation of the SiC coating is better than that of the VN coating shown in Fig. 6(e). The farther away the frictional ball is, the little the crack generation will be. This result also can be

found in the Fig. 7(b) and Fig. 7(d). Without the protection of composite coatings, the crack generation of C/C composites is easy.