# Supplementary Materials

# Heat Transfer and Hydrodynamic Properties Using Different Metal-Oxide Nanostructures in Horizontal Concentric Annular Tube: An Optimization Study

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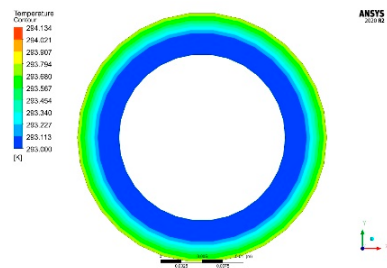ul. Norwida 25, 50-375 Wrocław, Poland

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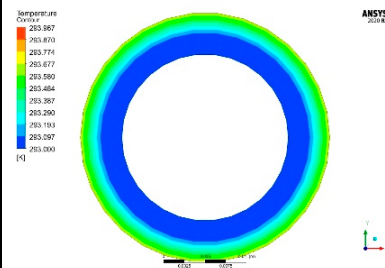
**\*** Correspondence: miklas.scholz@tvrl.lth.se (M.S.); yaseen@alayen.edu.iq (Z.M.Y.)
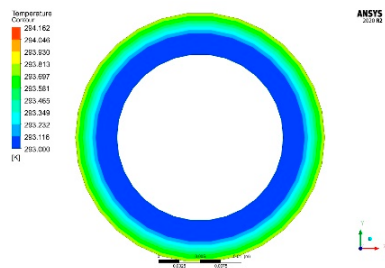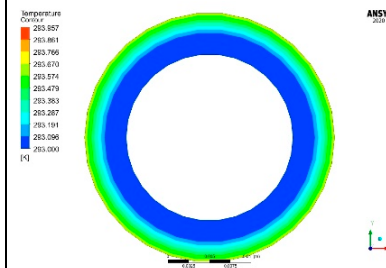
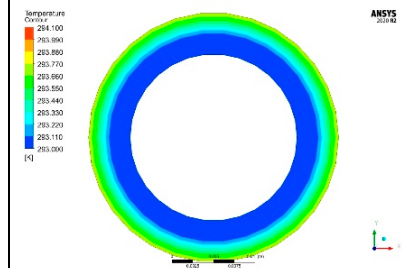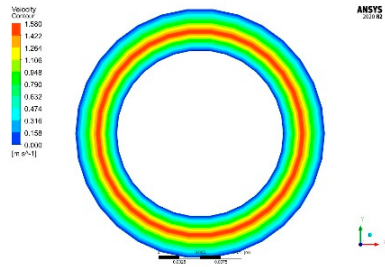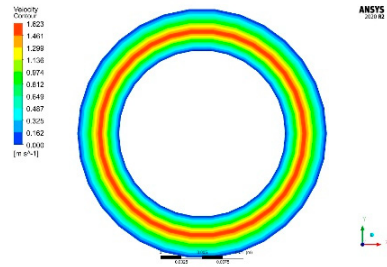Al₂O₃-Nanoblades          Al₂O₃-Nanobricks          Al₂O₃-Nanocylinders          Al₂O₃-Nanoplatelets          Al₂O₃-Nanospheres
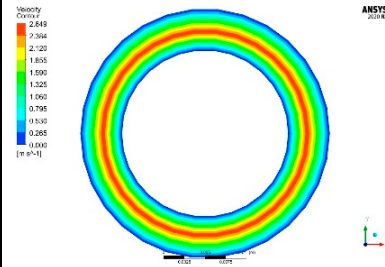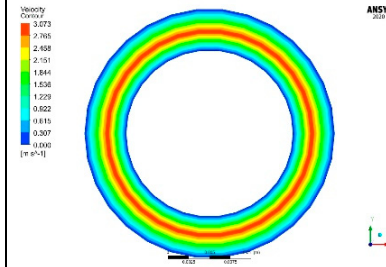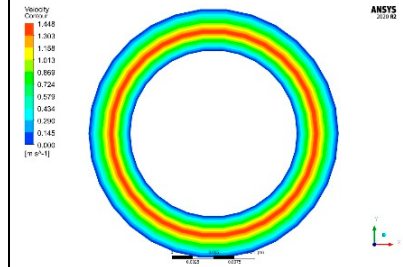
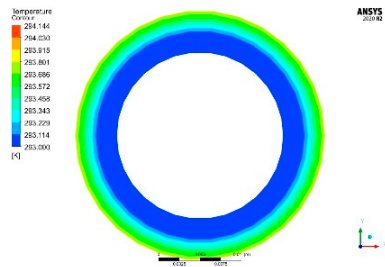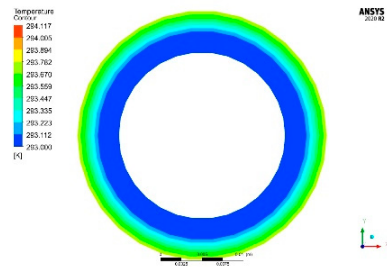Al₂O₃-Nanoblades          Al₂O₃-Nanobricks          Al₂O₃-Nanocylinders          Al₂O₃-Nanoplatelets          Al₂O₃-Nanospheres
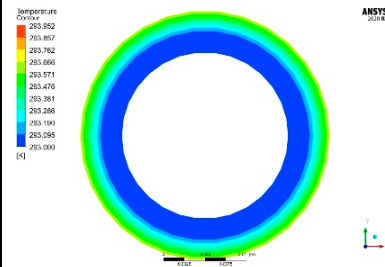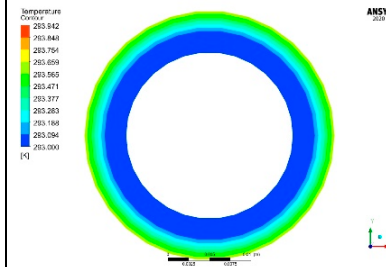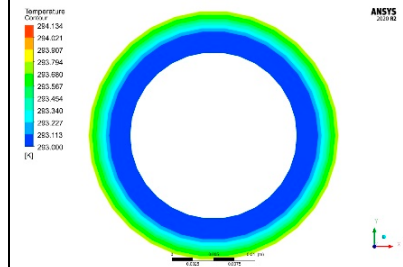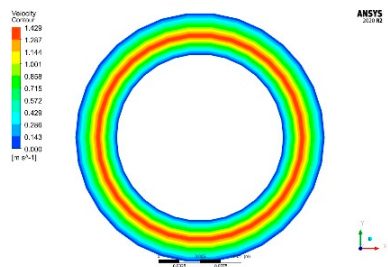
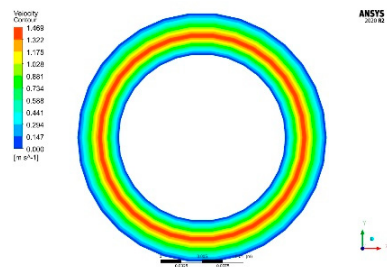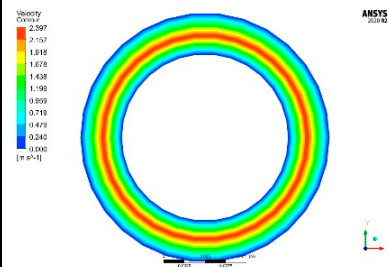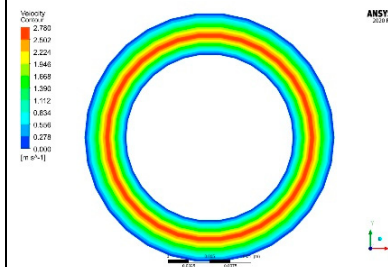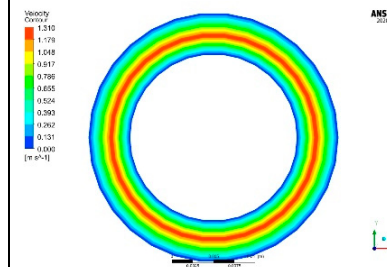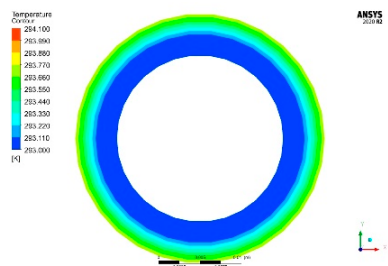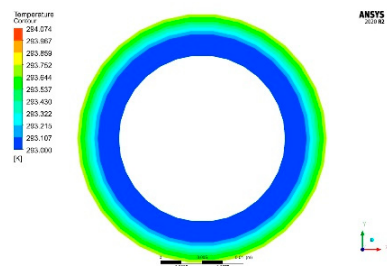CuO-Nanoblades          CuO-Nanobricks          CuO-Nanocylinders          CuO-Nanoplatelets          CuO-Nanospheres
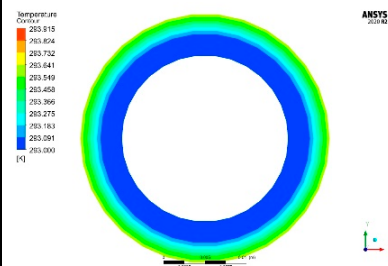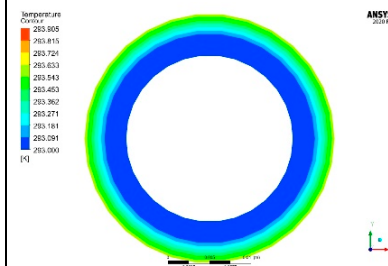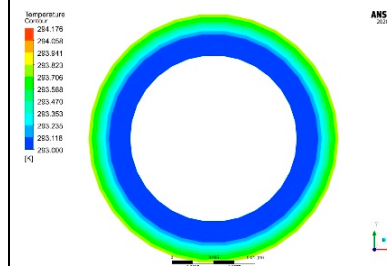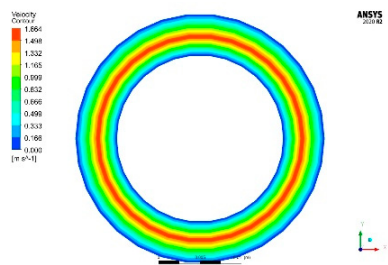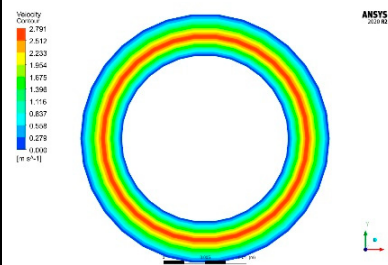
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CuO-Nanoblades

CuO-Nanobricks

CuO-Nanocylinders

CuO-Nanoplatelets

CuO-Nanospheres

SiO$_2$-Nanoblades

SiO$_2$-Nanobricks

SiO$_2$-Nanocylinders

SiO$_2$-Nanoplatelets

SiO$_2$-Nanospheres

SiO$_2$-Nanoblades

SiO$_2$-Nanobricks

SiO$_2$-Nanocylinders

SiO$_2$-Nanoplatelets

SiO$_2$-Nanospheres

ZnO-Nanoblades    ZnO-Nanobricks    ZnO-Nanocylinders    ZnO-Nanoplatelets    ZnO-Nanospheres
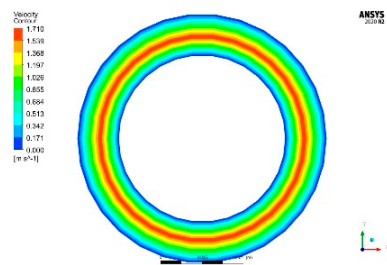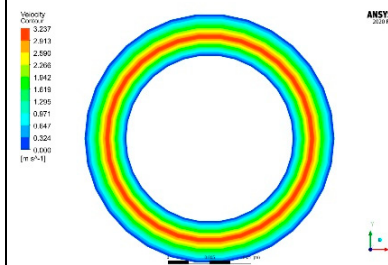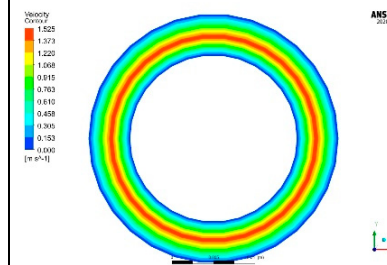
ZnO-Nanoblades    ZnO-Nanobricks    ZnO-Nanocylinders    ZnO-Nanoplatelets    ZnO-Nanospheres
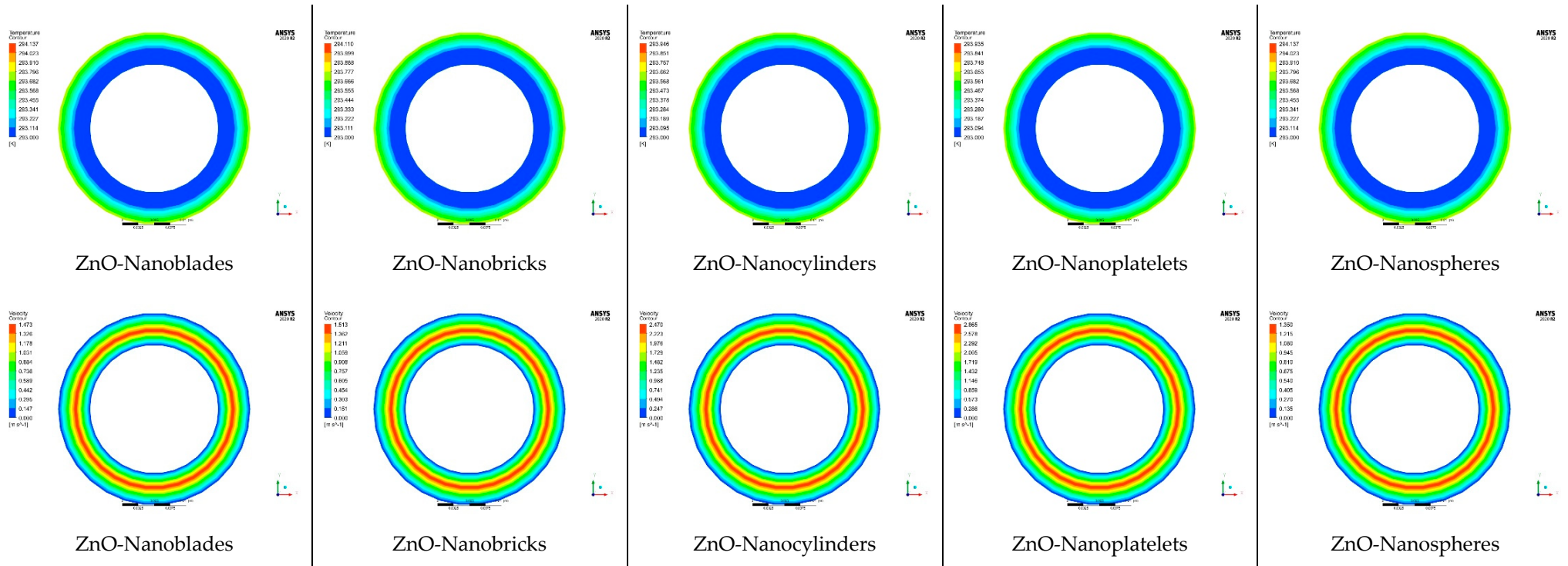
**Figure S1.** Temperature and velocity contours of different nanofluids and different nanoparticles shape under the conditions of 4 vol.%, 20 nm, 293 K, Re = 10,000 and 5000 W/m².
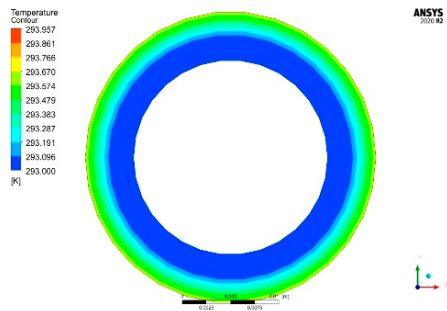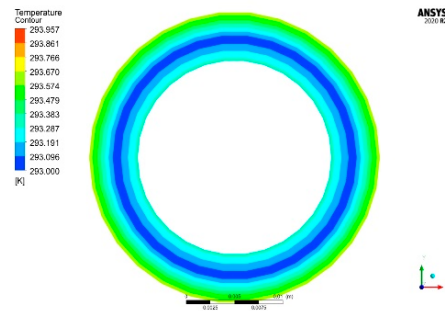
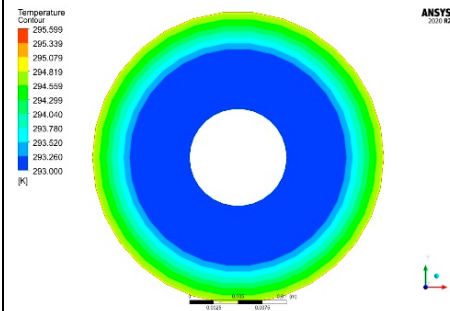Al₂O₃-Nanoplatelets-HFR-0  Al₂O₃-Nanoplatelets-HFR-0.5  Al₂O₃-Nanoplatelets-HFR-1  Al₂O₃-Nanoplatelets-HFR-2
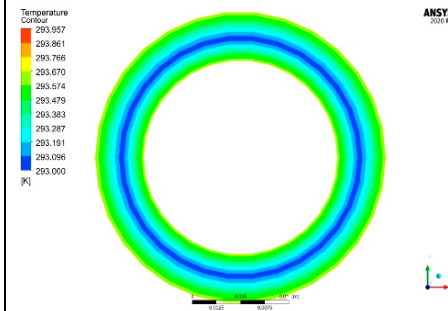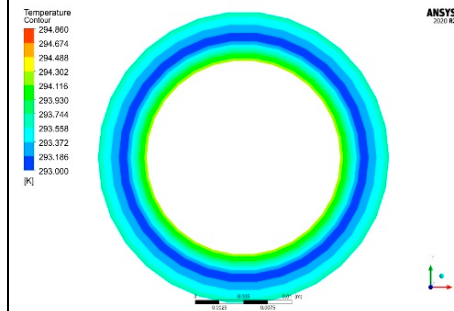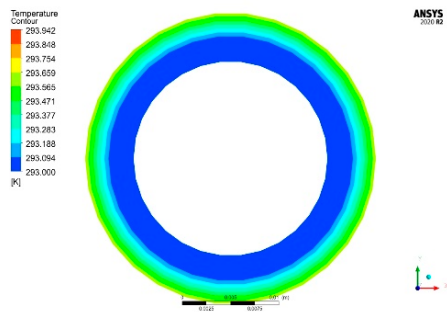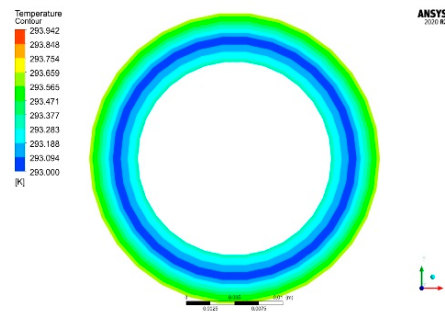
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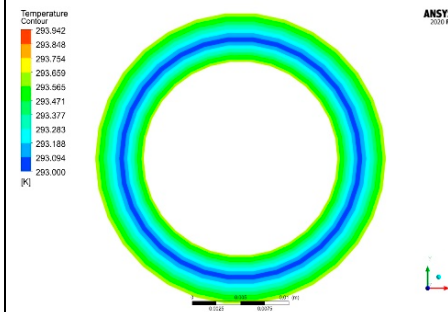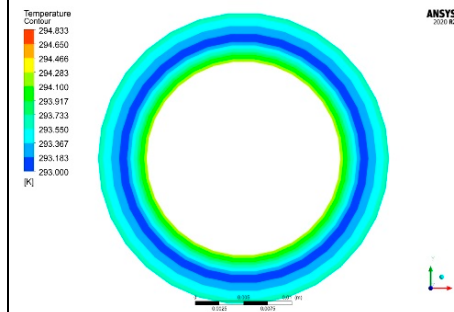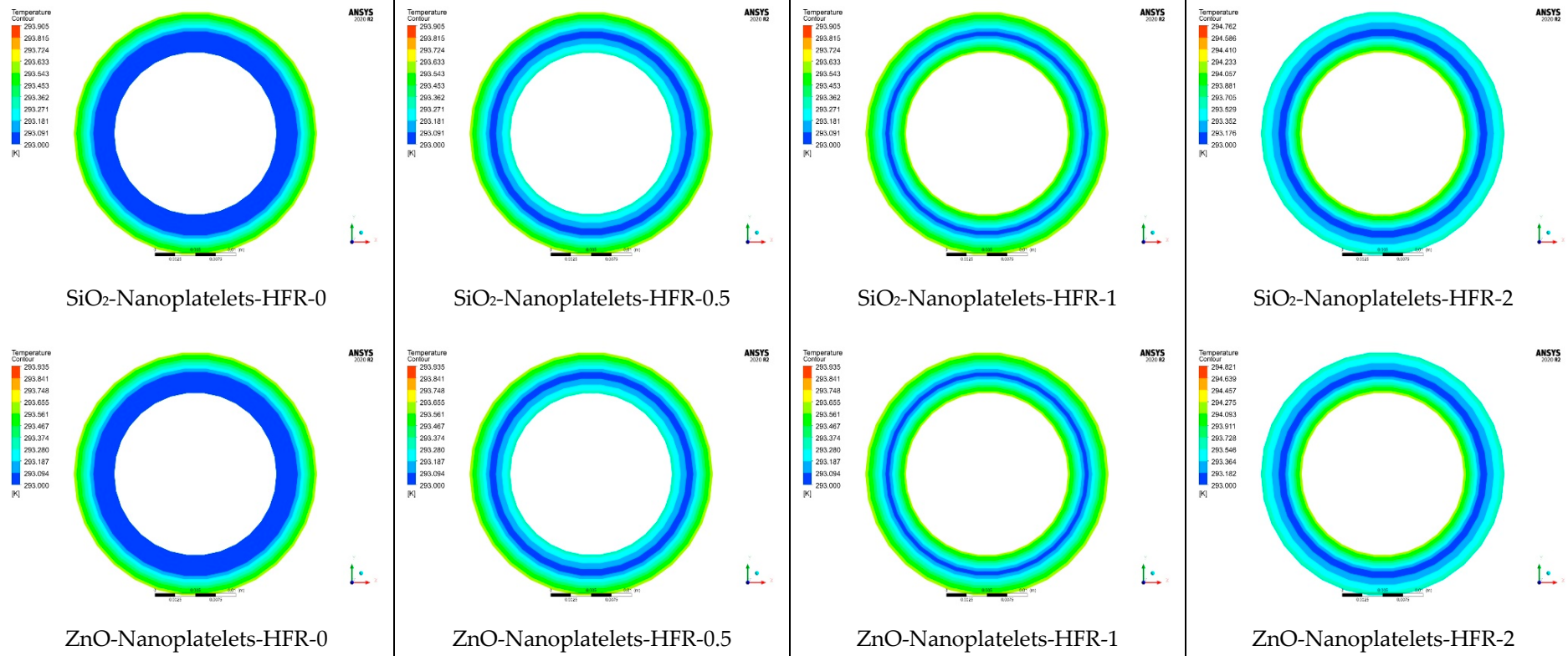
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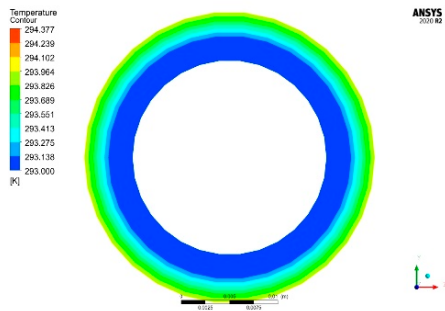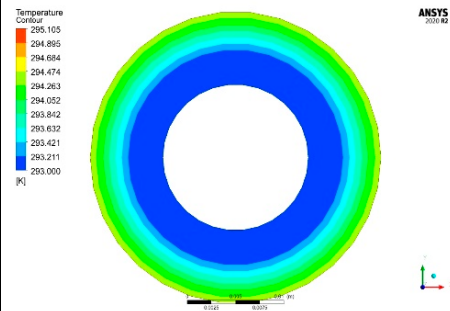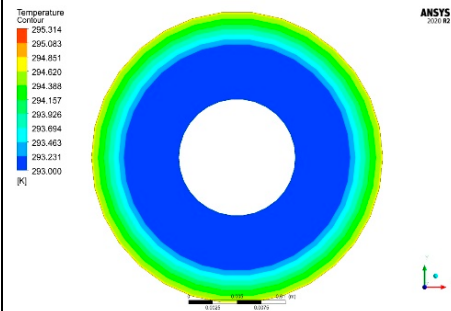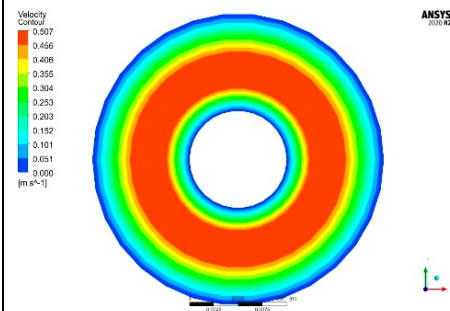
DW-T-AR@1.5  DW-T-AR@2  DW-T-AR@2.5  DW-T-AR@3
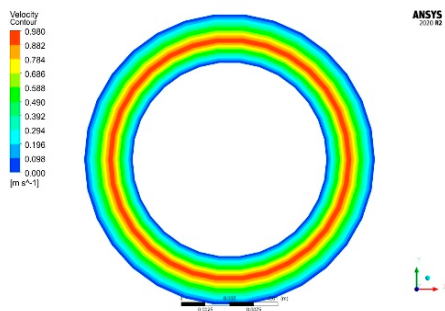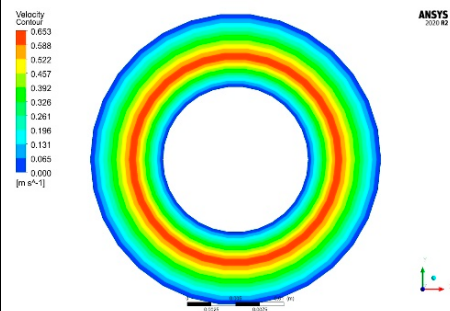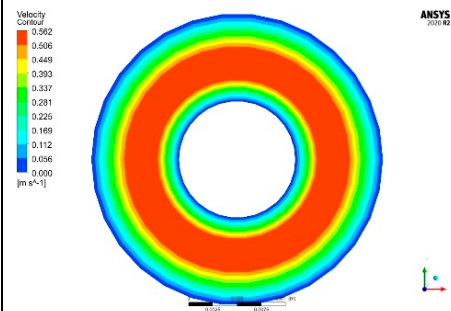
DW-V-AR@1.5  DW-V-AR@2  DW-V-AR@2.5  DW-V-AR@3
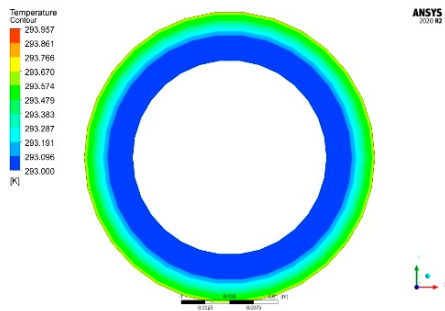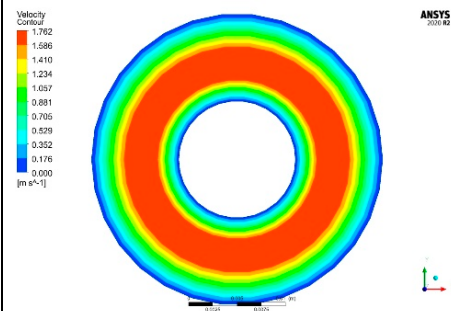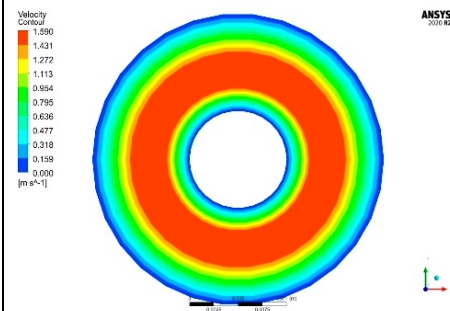
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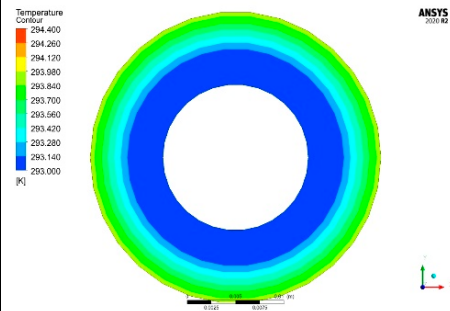
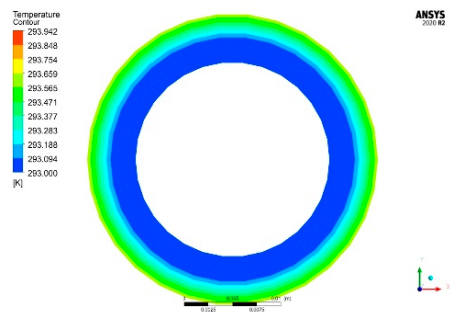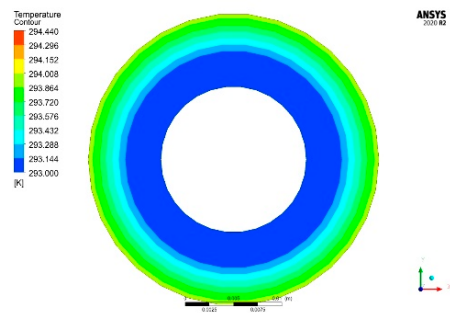Al₂O₃-T-AR@2
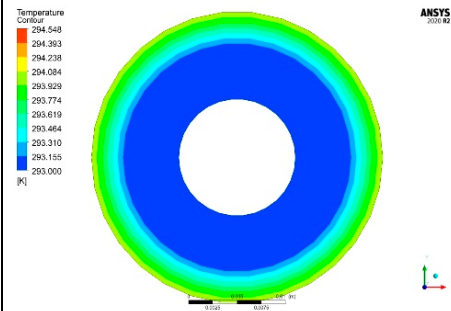
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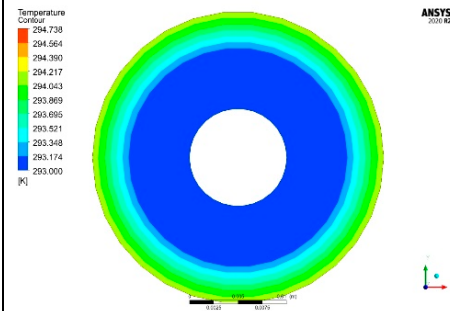
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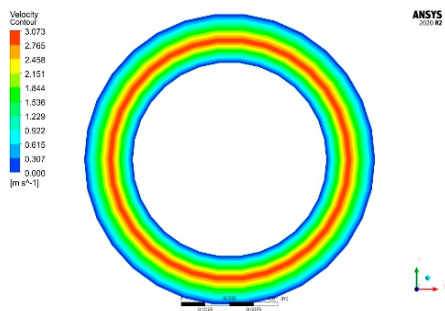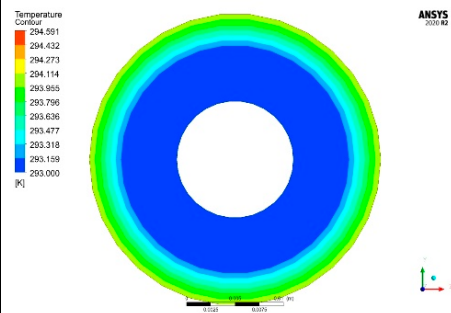
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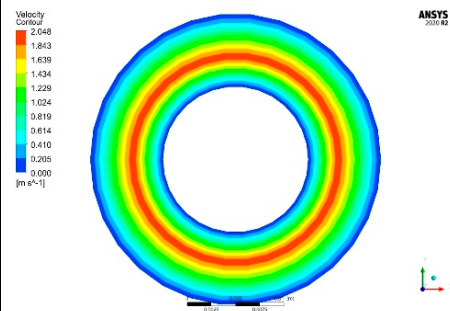
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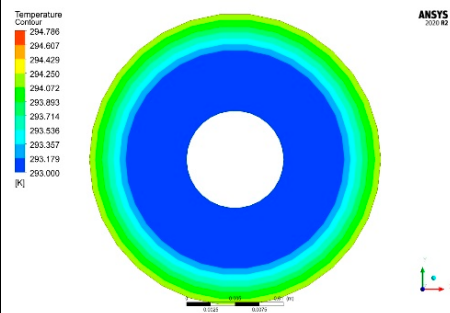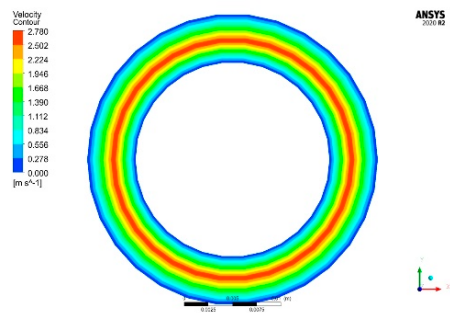
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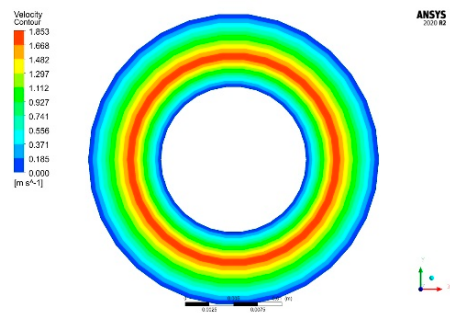
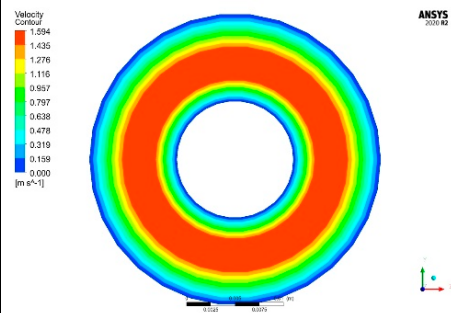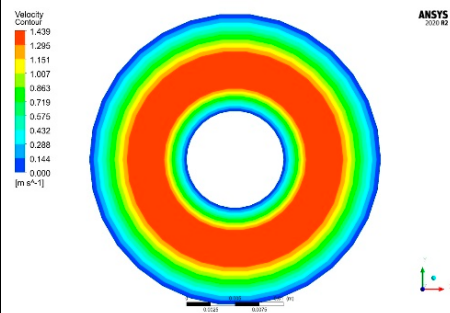CuO-T-AR@1.5          CuO-T-AR@2          CuO-T-AR@2.5          CuO-T-AR@3
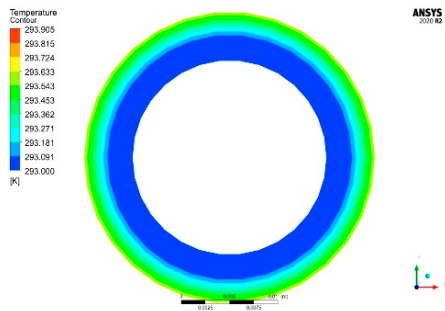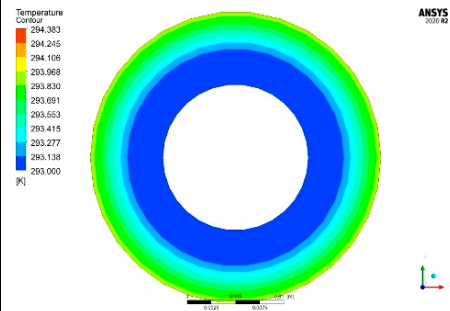
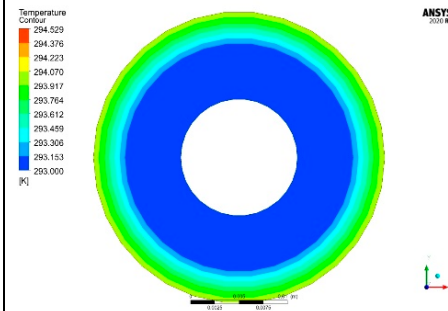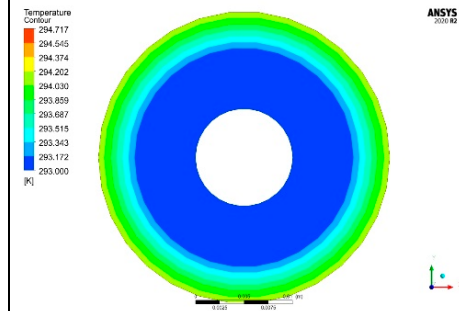CuO-V-AR@1.5          CuO-V-AR@2          CuO-V-AR@2.5          CuO-V-AR@3
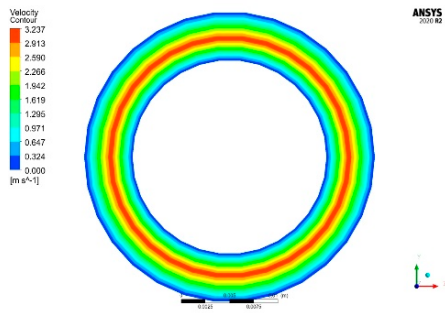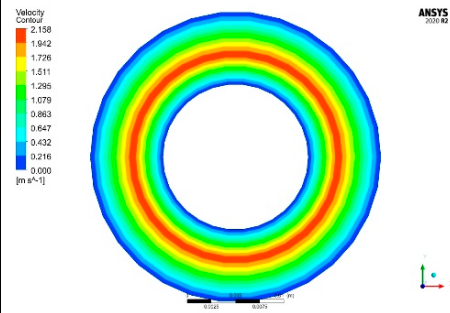
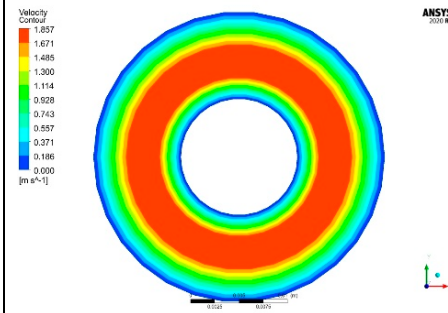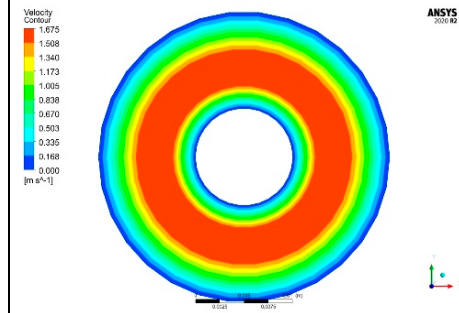SiO₂-T-AR@1.5    SiO₂-T-AR@2    SiO₂-T-AR@2.5    SiO₂-T-AR@3

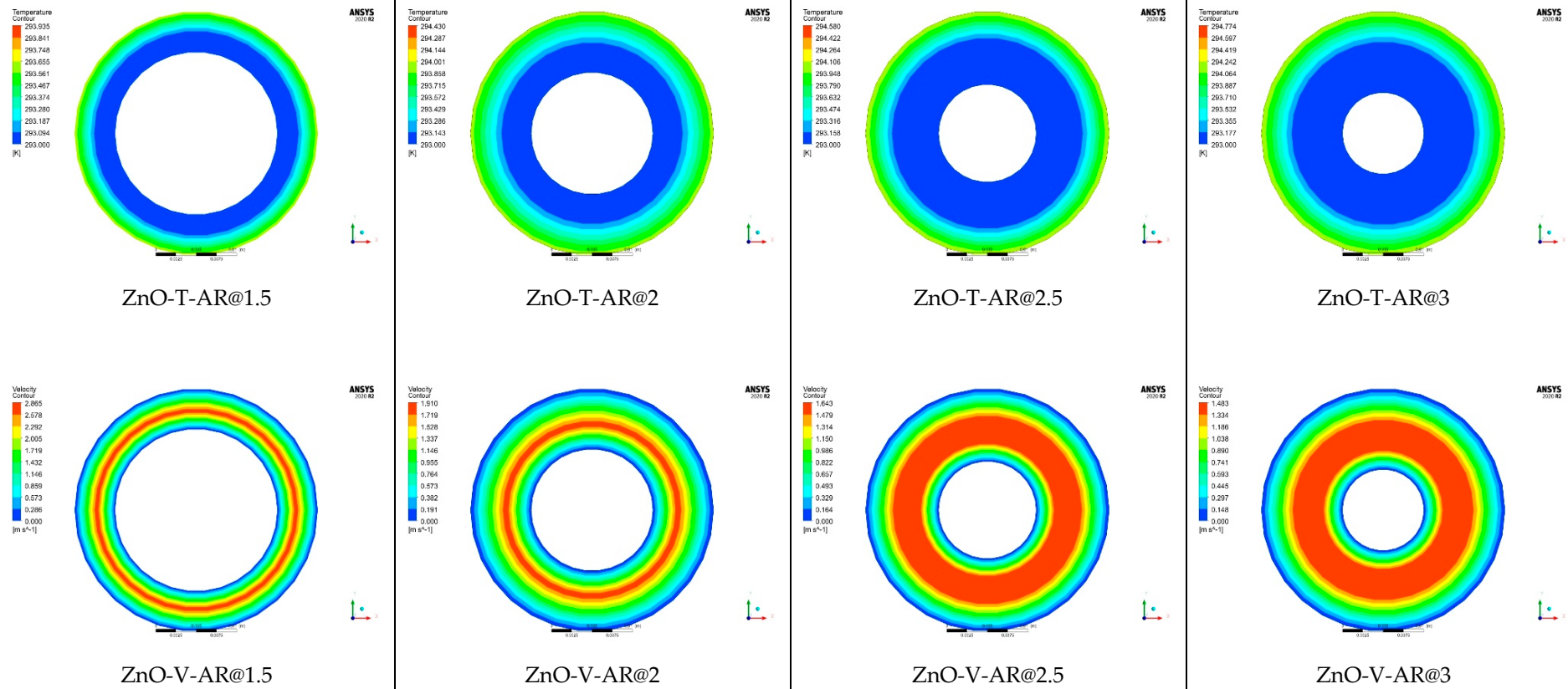SiO₂-V-AR@1.5    SiO₂-V-AR@2    SiO₂-V-AR@2.5    SiO₂-V-AR@3

**Figure S3.** Temperature and velocity contours of DW and different nanofluid types (Al₂O₃, CuO, SiO₂, and ZnO) at 4 vol.%, 20 nm, 293 K and Re = 10,000.