Low Dimensional Materials: Syntheses, Structures, and Optical Properties of Rb$_2$CuTaS$_4$, Rb$_2$CuTaSe$_4$, RbCu$_2$TaSe$_4$, K$_3$Ag$_3$Ta$_2$Se$_8$, and Rb$_3$AgTa$_2$Se$_{12}$

Yuandong Wu, Christian Näther, and Wolfgang Bensch

Institut für Anorganische Chemie, Christian-Albrechts-Universität Kiel, Olshausenstraße 40, D-24098 Kiel, Germany

Reprint requests to Prof. Dr. W. Bensch. Fax: +49-(0)431-880-1520.
E-mail: wbensch@ac.uni-kiel.de

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Dedicated to Professor Kurt O. Klepp on the occasion of his 60th birthday

The new compounds Rb$_2$CuTaS$_4$ (1), Rb$_2$CuTaSe$_4$ (2), RbCu$_2$TaSe$_4$ (3), K$_3$Ag$_3$Ta$_2$Se$_8$ (4), and Rb$_3$AgTa$_2$Se$_{12}$ (5) have been synthesized by the reactive flux method at 773 or 873 K. Their crystal structures were determined by single crystal X-ray diffraction. Crystal data for 1: space group Fddd, $a = 5.598(1)$Å, $b = 13.512(4)$Å, $c = 23.854(5)$Å, $Z = 8$; Crystal data for 2: space group Fddd, $a = 5.782(1)$Å, $b = 13.924(3)$Å, $c = 24.653(5)$Å, $Z = 8$; Crystal data for 3: space group C2cm, $a = 5.7218(3)$Å, $b = 19.2463(13)$Å, $c = 7.7456(5)$Å, $Z = 4$; Crystal data for 4: space group C2/c, $a = 25.1374(19)$Å, $b = 6.1007(3)$Å, $c = 14.4030(11)$Å, $\beta = 119.703(8)^o$, $Z = 4$; Crystal data for 5: space group P2$_1$/n, $a = 9.8186(6)$Å, $b = 13.7462(11)$Å, $c = 15.7368(9)$Å, $\beta = 96.681(7)^o$, $Z = 4$. The compounds 1 and 2 are built up of $^1_{\infty}[\text{CuTaQ}_4]^{2-}$ anionic chains which are formed by edge-sharing CuQ$_4$ and TaQ$_4$ tetrahedra. The rubidium cations are located between the chains. Compound 3 consists of $^2_{\infty}[\text{Cu}_2\text{TaSe}_4]^{2-}$ anionic layers separated by rubidium cations. The anionic layers are formed by $^1_{\infty}[\text{CuSe}_4]^{2-}$ chains which are connected by CuSe$_4$ tetrahedra that share common edges with the TaSe$_4$ tetrahedra of neighboring chains. In compound 4 $^3_{\infty}[\text{Ag}_3\text{Ta}_2\text{Se}_8]^{3-}$ anionic chains are found which are separated by potassium cations. These chains are formed by successive corner sharing of AgSe$_4$ tetrahedra and edge sharing between AgSe$_4$ and TaSe$_4$ tetrahedra. All three structures are closely related with the sulvanite (Cu$_3$VS$_4$) structure type. Compound 5 contains a one dimensional $^1_{\infty}[\text{AgTa}_2\text{Se}_{12}]^{3-}$ anionic chain formed by interconnection of AgSe$_4$ tetrahedra and [Ta$_2$Se$_{11}$] units. In the structure three monoselenide, three diselenide, and one triselenide anions are found. Raman and far-IR spectroscopic data of compounds 1 and 4 were collected and an interpretation is presented.

Key words: Tantalum Compound, Quaternary Chalcogenides, Crystal Structures, Flux Reaction, Optical Properties